

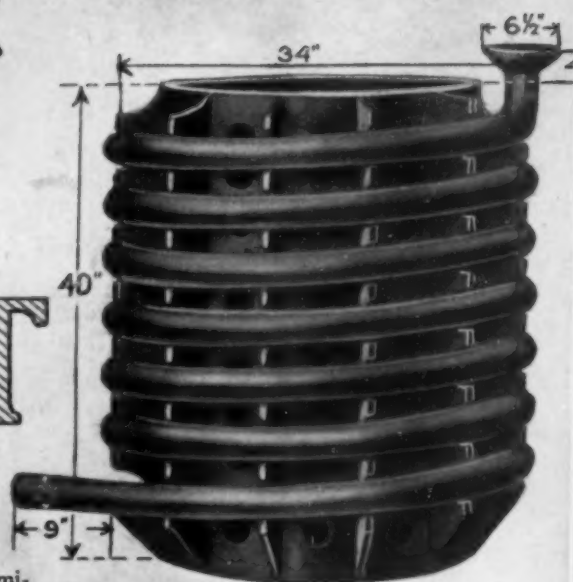
Metallurgical & Chemical Engineering

New York, March 15, 1918

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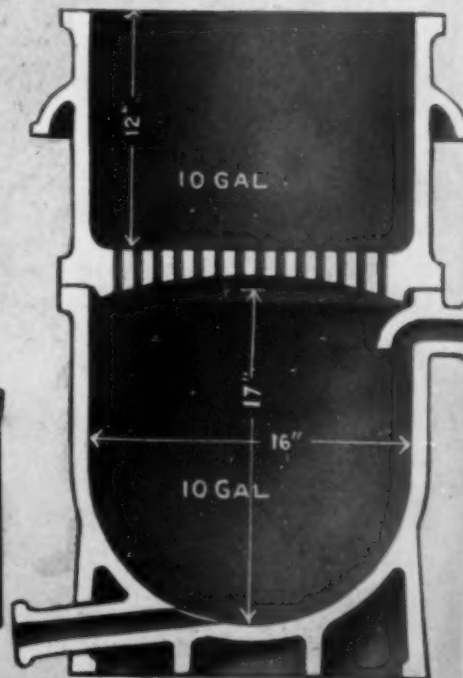
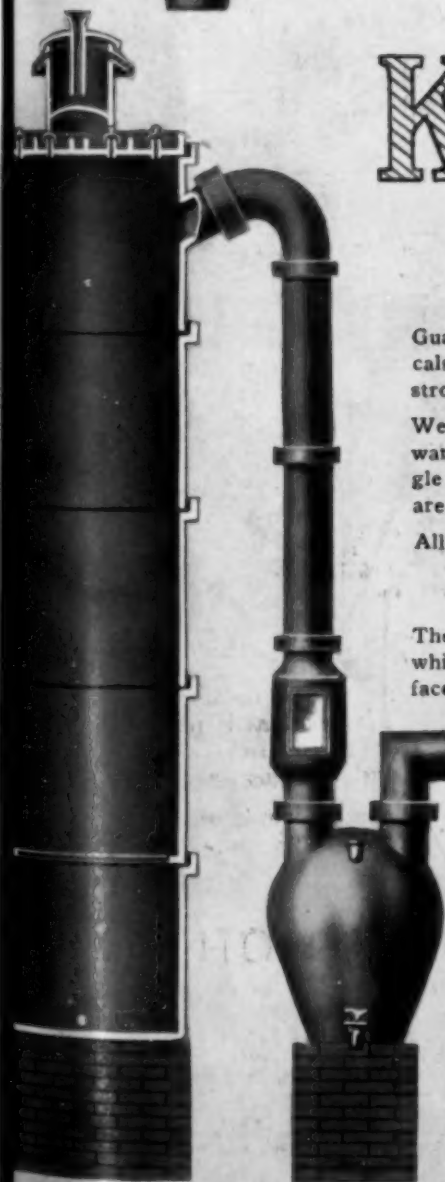
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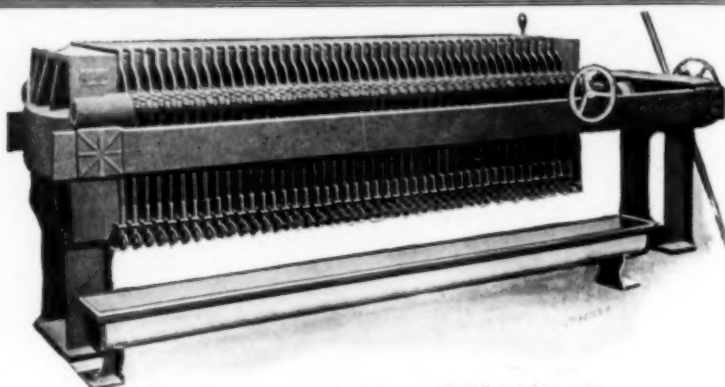
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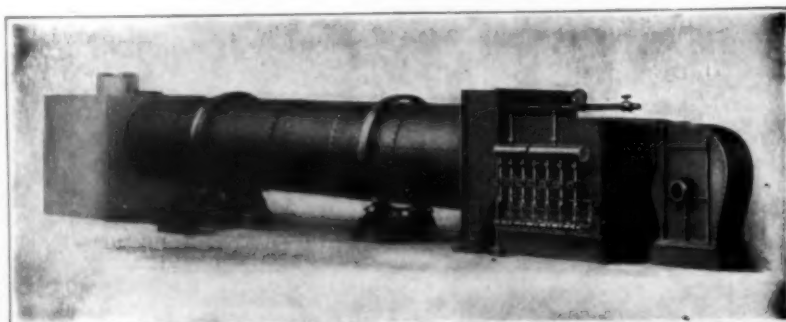
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Playing with Platinum Prices

THERE are some metals of such limited known distribution in the earth's surface that their economics are comparatively simple and easy of comprehension. Platinum is one of them. Produced for the major part in the Urals of Russia, and latterly to an important extent in Colombia, the metal is recovered only incidentally elsewhere. With the Russian supply curtailed, if not entirely cut off, the prospect for platinum in plenty is not alluring, and Colombian sources assume an aspect of greater importance.

The supply of platinum in the United States may fall short of demand; at least that is a fair inference from the order of the War Industries Board, which we publish elsewhere, commandeering platinum supplies in this country. Putting together the facts just stated, viz., that we face a platinum shortage and that the only places from which we can get it in quantity are Russia and Colombia, it would seem to be fair business sagacity to offer an inducement for the production of platinum and its shipment to this country. At least we should not deliberately place any obstacles in the way.

For over a year the prices of platinum have been fairly stable at \$103 @ \$105 per ounce. We are informed, however, that the War Industries Board proposes to pay only \$90 per ounce for the 20,000-oz. lot brought from Petrograd some months ago by Mr. Draper. Presumably if so inconsiderate a proposal is made in this instance, domestic dealers who have no alternative will fare no better. We may now frame a simple question: Under the conditions just outlined, how much platinum will the War Industries Board be likely to get? The answer seems equally simple: Just about the available stock now in the United States, and no more. And yet we face a shortage of platinum, and produce practically none of it in this country.

Within the period of the war it has been amply demonstrated that economic laws still work in the case of needed metals. The memory of the tungsten boom is still fresh in the minds of many. Tungsten was suddenly needed in large quantities. The price rose rapidly and became so attractive that people literally combed the hills of Boulder county, Colorado, getting a bucket-full of high-grade float in the course of a few days. A great deal of the mining was crude and much of the milling was wasteful; but we got tungsten, and the price stayed up until it attracted supplies from Burma and other foreign countries where the mineral was laboriously accumulated by natives. Even their simple wants could not be met by shipping tungsten to this country when the market was normal. It took a stimulus in the form of a high price to make them active producers. Supplies having been brought out plentifully, the price fell off and has remained down ever since. We commend the incident to the War Industries Board.

Post-Mortem Reports

METALLURGISTS are agreed, privately, that a public record of failures and negative results would be quite as beneficial to the profession as the more customary announcement of successes. For this reason we consider it important to publish in this issue an account of a careful but unsuccessful effort to treat sulphide copper ores with nitric acid. Mr. Westby is to be commended not only for a clear discussion of the chemistry of the method, but for a frank revelation of an unsuccessful attempt to supply a process which had gained considerable notoriety in the West and which was heralded as a solution of some of our metallurgical problems.

A striking point among the reasons for failure was the inability to make a complete recovery of the solvent—nitric acid. The commercial meaning of even a three per cent loss was painfully evident when costs were estimated. The results of ten tests with laboratory apparatus indicated an average nitric acid recovery of 90.5 per cent and an average copper extraction of 88.9 per cent. The former is distinctly poor and the latter not strikingly good. In large-scale tests the results were not nearly so good. Compared with roasting and leaching with sulphuric acid, the nitric acid process held no attractions in estimated profits, for under the most favorable assumptions of recovery of acid and copper the nitric acid process showed an estimated net profit of only \$2.46 per ton as against \$3.27 by roasting and leaching with sulphuric acid.

Iron and Steel Price-Fixing

THE iron and steel industry is quite accustomed to kaleidoscopic changes, and war brings its own sudden and great changes, so that it is not surprising that conditions in the steel industry are radically different from those that obtained six months and twelve months ago. A year ago steel prices were trending upwards very sharply indeed. To-day the question is whether the War Industries Board will seek lower prices for the next period, the present set prices having been, by the announcement of last December, extended to March 31. On an average, the present set prices are approximately at the same level as the market of one year ago. Price-setting simply eliminated the additional advances that occurred March to June inclusive of last year.

There are, in essence, two important changes that have occurred in the position of the War Industries Board which, with the President's approval, represents the government. The first change is really the absence of a change that was expected to occur. Last December, when the War Industries Board approved an extension of the set prices to March 31 of this year, the expectation was entertained that long before the new date had arrived the Pomerene or some other iron and steel price-fixing bill would have passed Congress. The authorities at Washington expected they would have some legal authority over iron and steel prices in general, of somewhat the same character as the authority that was given by the Lever act of August, 1917, with respect to "food, feed and fuel." The proposed legislation was dropped, however, partly, no doubt, because Congress has been so busy—in the Congressional sense—with other legislation that it could not consider iron and steel, but partly also, beyond question, because

the iron and steel industry was found so ready to follow instructions or requests, no matter upon what authority they rested, that legal enactment did not seem necessary. Thus the War Industries Board to-day is without a legal authority that it was expected to possess by this time.

The other important change is that the tactical position of the government in this matter is altogether altered. During the months in which a voluntary agreement—the expression may be somewhat tautological but it is sanctioned by usage—was sought, the position of the steel makers was that government orders were accepted solely as a patriotic duty while ordinary commercial orders represented a much larger tonnage and much higher prices.

By legislation enacted before the war started, the government was empowered to fix "fair" prices upon any material it bought. For a time the view of the steel industry was that the government should go ahead and fix prices on its purchases, leaving the industry to fix its own prices on the steel sold to the general public. The latter represented by far the larger tonnage. President Wilson insisted this would not do, that there should be "one price for all." Finally he enunciated his views in a very clear and direct statement, July 12, which statement was received with much consternation and some criticism, but has since been tacitly accepted universally as a necessary and eminently proper rule of conduct.

Nine months ago the iron and steel market was still "going strong." With the government empowered to fix prices on the material it bought, and on nothing else, to propose that there should be one price for all seemed like proposing that the tail should wag the dog. Since then there has been a complete reversal. If the government were now to fix prices upon all material required for the war and leave producers to name prices themselves upon all other material the government would be fixing prices upon the bulk of the material, not upon a minor part. It has taken over the railroads, and it could go farther and take over bodily the petroleum industry, the motor car industry, and some others, leaving little steel consumed on the outside, when building operations for peace purchases have dwindled to insignificant proportions. Thus the War Industries Board is now so well fortified that apart from considerations of patriotism it is practically in control.

There is in fact no question of authority and no general divergence of opinion. The matter of iron and steel prices has become purely one of expediency, what is best for the country. On the one hand, the prices to be paid for pig iron or steel should not be exorbitant, whether it is the government, its Allies, or the general consuming public that is the buyer. On the other hand, prices should be such as to afford reasonable profits to the manufacturers, not to the few, but to the great majority, to all except those manifestly inefficient. The government elected to obtain a large part of its war chest by taxation, and elected furthermore to tax production rather than consumption. There must be profits to be taxed or the scheme falls to the ground.

Conditions have been such in recent months, with greatly restricted output and correspondingly mounting costs, and costs varying widely from week to week and from plant to plant, that it is a practical impossi-

bility at the moment to determine closely what is a fair price. Compared with some recent costs the present prices may be too low. By other comparisons they may appear too high. The industry hopes for better operations and steadier costs even in the next few weeks now that the season has changed. The wise course will probably be to let the present price structure stand without disturbance for a time at least.

The Crystal-Gazer

THE crystal-gazer who could read the past, present and future of the world by concentrating his attention upon a small silvered ball, has his scientific counterpart in the metallographist who cuts a few ounces of metal from the lining of a huge rifle, gazes at these fragments through his microscope, and proceeds to reconstruct the behavior of the sixty-ton bulk during and after the lightning flash of powder and shell. Who shall attempt to predict the limits to the metallographer's domain when some studies in the quiet of laboratory and library reveal the metal's travail during catastrophic explosions?

A most striking example of the efficacy of accurate observation and clear reasoning in the solution of the problems of industry is presented in a paper on "The Erosion of Guns" read at the New York meeting of the American Institute of Mining Engineers by that remarkable American, Henry M. Howe. We published a summary in our last issue, but for the entire article we bespeak the closest study. Even the non-metallurgical reader can admire this investigation for its sheer beauty, while the metallurgist will derive inspiration and courage in this evidence of the important work which is possible even with a moderate amount of instrumental equipment when reinforced with a large amount of intellectual resource.

Ammonia, Refrigeration and Munitions

VERY serious need just now is that of ammonia. There is a demand for it by the government so great as to tax every possible source of supply, and the question may soon have to be met as to where the use of ammonia may be curtailed. The United States Government requirements for May, 1918, are three times, and for December, 1918, seven times its requirements for February of this year; but government nitrate-producing plants are under construction and it is hoped that they may be completed in time to avert any serious dislocation of industry.

The largest industrial use is for refrigeration. Of the 6,000,000 tons of ice annually used in New York City, for example, about one-half is artificial. Ten cities of the United States produce annually about 8,000,000 tons of artificial ice, and most of this is refrigeration by the ammonia process.

The United States Food Administration is taking the matter in hand and is urging with energy the harvesting of natural ice wherever possible, and hints and directions for doing this are sent broadcast. Ice-producing plants are urged to co-operate for the saving of ammonia and fuel, and such co-operating parties are urged to avoid legal complications or the infringement of anti-trust laws by conferring with local officials in this emergency. All refrigeration establishments are urged to stop losses of ammonia, to eliminate

corroding factors from their circulating liquors, to return empty cylinders to supply firms and to harvest all the natural ice they can. Every coal-gas plant that consumes over 5000 tons of coal per year is urged to save its ammoniacal by-products. Parties contemplating the erection of new artificial ice plants have been addressed by the Food Administration through its Division of Chemicals, pointing out the pressing need of ammonia for munitions and its prospective shortage. They are urged to postpone such undertakings. Over a dozen booklets have been prepared and are distributed to municipalities on the safe and proper use of natural ice. Trading in ammonia, ammonium sulphate and ammoniacal liquors in quantity has been placed under license, and manufacturers are cautioned not to buy over 60 days' supply. Hoarding will be punished by cutting off the entire supply.

From the foregoing it will be observed that Mr. Charles W. Merrill, chief of the Division of Chemicals of the U. S. Food Administration, is not letting the grass grow under his feet.

The only trouble with substituting CO_2 and SO_2 for NH_3 in plants which are designed for the use of ammonia is that in the present state of the art it can't be done. The compression pressure required for ammonia is from 185 to 200 lb. per square inch. For carbon dioxide from 1000 to 1200 lb. is needed. It stands to reason that apparatus built to withstand 200 lb. will not endure 1200. The compression pressure required for sulphurous oxide is low, but the pump and refrigeration pipes must be made of brass or copper for obvious reasons. SO_2 does not behave well in iron and on the other hand NH_3 gets nervous in copper or brass. There does not seem to be any way available in the light of present knowledge to shift from ammonia to carbon dioxide or sulphurous oxide or any other gas in ammonia refrigeration apparatus. And considering the need of mechanics in the industry of war, new equipment is not available.

Large quantities of ammonium nitrate are used in domestic explosives. Under normal conditions, produced at an expense of 6 or 7 cents per pound, it is the cheapest explosive ingredient of blasting powder. With glycerine at 60 to 65 cents a pound, and almost impossible to get at that, the use of high explosives for this purpose is prevented and a heavy burden as well as a serious problem is placed upon the mining interests. The conversion of starch to glycerine is still very indefinite. It has not yet reached an economic stage.

There are certain economies proposed by Col. Walker that do not come under such close surveillance as those industries under observation of the Food Administration, and to these we not only call the attention of our readers but invite suggestions as to the best methods of carrying them out.

Old, exhausted, dry batteries are usually thrown away. This is a serious waste, as they still contain 80 per cent of their ammonium chloride and all of their manganese dioxide. If these were exchanged when new ones are purchased, instead of thrown away, an economy in charging and in the use of ammonia would be effected. Galvanizing works also are large users of ammonium chloride, and one has but to enter them to see waste in many instances. In the preparation of soldering fluids and fluxes the use of ammonium chloride should be discouraged as far as possible.

Readers' Views and Comments

Co-ordinating Production and Transportation

To the Editor of Metallurgical & Chemical Engineering

SIR:—There are indications on all sides that we are approaching an industrial and economic crisis. One of the most evident signs of this is the amount of criticism which is being showered on those in charge of Government activities, nearly all of which at present relate to the war. The attempts to blame these various inefficiencies on individuals are being made on all sides. It was only natural in this confusion that army officers and Government officials in general should be the first to receive the blow, for we have always held the theory that Government officials were far more inefficient than our business men.

The number of applications from private manufacturers for the help of "efficiency engineers," which has so largely increased lately, is indicative of a realization on the part of many of our manufacturers that their methods also are not what they should be. The people who are applying for help are, in many cases, no worse off as far as their methods are concerned than others who haven't yet discovered how badly they are doing their work. The whole subject seems to resolve itself into the fact that our business and industrial systems are not suited for times like these, when it is necessary to combine all our energies and exert our full driving power toward the achievement of one supreme object.

We should not be surprised that this is the case, for our economic theory has never contemplated teaming up all the industries of this country for one object, but has rather discouraged that idea and encouraged individual competition of the most strenuous kind. In other words, we are a nation of individualists who have never really seriously contemplated coöperation for the common good.

PAST TRAINING UNSUITED TO PRESENT NEEDS

When this problem of coöperation is suddenly put up to us as it has been by the war, it is not surprising that our business men, trained in the individualistic school, should be entirely unfitted to solve the new problem. Moreover, it might be expected that the men who have been most successful in individualistic, competitive business, in which profit was the main aim, should be actually the ones least fitted to establish a scheme of business and production for the benefit of the community. This is a new problem to them, and one altogether outside of their experience.

It is to be granted that such business men may have individually great driving power, but this very excess of driving power in individuals or corporations is likely to make the confusion all the worse, unless a means of co-ordination is established which will keep the driving power of the individuals or corporations in proper balance.

It has become perfectly evident to all observers that the capacity of the nation for production of war material is enormously greater than its capacity for ship-

ping it to Europe, and that we must at once not only balance this production, but slow it down in order to prevent such a choking of our eastern ports as may produce an impossible condition. The five-day shutdown ordered by the fuel administrator and the one-day-per-week shutdown are our first attempts to slow up this production, and we ask ourselves at once if this is the best way. The answer comes that if we are making too much war material we had better turn some of our activities into the manufacture of articles of peace. Immediately we run into the financial situation, which at present seems to seriously hamper new undertakings.

It would seem that the claim of the railroads that they need \$1,000,000,000 worth of improvements should at this juncture be considered. Here is one organization now devoted exclusively to the service of the community which, being under the control of the Federal Government, can be financed directly by that government, and there would seem no reason why the production programs of war material should not be limited, and a certain amount of the energy now being expended in that direction turned at once toward the improvement of our transportation facilities.

This is the first suggestion that occurs to one as a means of avoiding the economic situation which seems to be forcing itself upon us. If we can afford to spend billions for war, should not our Government be authorized at once to turn whatever surplus energy has been inadvisedly called into this work into channels that will be beneficial to the community in time of peace?

OVERPRODUCTION A MENACE

After nine months of confusion, it is becoming perfectly clear that as far as we are concerned, in this country at least, our war problem is one of production and transportation on a huge scale.

The critical point to-day is recognized on all sides to be our ability to transport material to Europe. We have in the past repeatedly had estimates as to what transportation facilities we should have, but it is only recently that any real attempt has been made to study the transportation problem thoroughly and to find out what the limiting factors were and how they could be improved. It is hoped that through the investigation which is now being made we shall shortly have exact knowledge on this subject.

In the meantime, however, we already have approximate knowledge which indicates that our production of war material is rapidly outrunning the possibilities of transportation.

Early in December Dean Schneider, working for the Ordnance Department of the army in Washington, warned General Wheeler, Acting Chief of Ordnance, of the situation which is now impending, and the Ordnance Department began promptly to investigate the subject. Investigations of this subject by one department, however, are not sufficient. Our whole production program must be harmonized with the possibilities of over-seas transportation. In other words, an attempt should be made at once to balance our production of war material of all classes with the possibilities

of transportation, and wherever necessary the production program should be slowed down at once in order that the congestion on our Atlantic seaboard may be relieved. The slowing down of this program means that energies which have been unwisely directed to war activities must be at once transferred back again to the industrial work which has to do with peace and the upkeep of our industrial organization.

This is necessary for two reasons:

First: If we are going to spend fifteen billions per year in war we must produce at least fifteen billions more material than we need for peace times, which means that our working plant must be kept in the best possible condition.

Second: If we do not realize that by the production of a surplus of war material we shall ultimately be compelled to cease that kind of manufacture and thereby suddenly throw out of work large numbers of men, we may precipitate an economic crisis of great magnitude.

H. L. GANNT.

Engineers in Training

To the Editor of Metallurgical & Chemical Engineering

SIR:—In the December 15, 1917, issue of your publication appeared an article by Robert Tudor Hill on "Engineers in Training." Professor Hill's orderly presentation of the subject and his carefully compiled tabular illustrations naturally attract the attention of one who is interested in educational work. This is especially true if one has had opportunity to observe and ponder over several of the conditions and tendencies to which Professor Hill calls attention.

READJUSTMENT OF ENGINEERING COURSES

It appears that in many technical schools the broader engineering courses are undergoing a process of remodeling and readjustment from year to year. Several factors are responsible for this variation. Every up-to-date engineering course must keep pace with developments in practice. Both equipment and methods of doing things are improving and changing at frequent intervals. The engineering course which is not adjusted to meet these conditions is not only subject to unfavorable comment from any interested critic, but rapidly becomes uninteresting to the wide-awake student who is beginning to take a serious interest in the field activities of his chosen profession. Therefore, improvement in engineering practice will compel a continual revision of engineering courses.

Another factor which disturbs the stability of an engineering course in some institutions is a process of experimentation which may be described as a struggle to reconcile two opposing tendencies, viz., on one hand to inject into a course the maximum amount of discussion of fundamental theory involved in the subject under presentation, and on the other hand to include in the instruction as many as possible of the so-called professional tricks or kinks used in practice. The first mentioned extreme may make the subject so dry and uninteresting to the average student that he will deny it the attention it deserves, and he may fail to absorb certain important ideas which would be devoured with pleasure if administered in more palatable form. On the other hand, an effort to present innumerable practical frills with the consequent crowding out of valuable

fundamental theory results in defeating the very object of ideal instruction, which is to inculcate ability to think properly in the face of an indefinite variety of emergencies, rather than learn how to perform a limited number of set tasks. The young engineer who has a firm grasp on fundamental theory is equipped for professional growth and expansion, and is likely to develop into a citizen of ever-increasing usefulness. The technical graduate who is short on theory may develop cleverness in solving certain problems, but he is likely to lack versatility, his growth may be limited, and he may fail to become more than a first-class mechanic in certain technical activities. The difference between these two products may be chargeable, in part at least, to faulty or inefficient technical training or instruction.

IMPORTANCE OF STUDY OF ECONOMICS

If the object of technical education is to develop professional ability calculated to increase industrial efficiency, then no presentation of an engineering problem is complete unless it has been discussed critically from an economic viewpoint. Every engineering project which requires the expenditure of money and contemplates the return of this money together with a profit commensurate with the risks involved, is essentially an economic problem and the technical features are really secondary in importance. If the project will not satisfy a critical investigation from a common-sense, business standpoint, the most interesting technical possibilities of the undertaking are of little consequence. In view of the variety and complexity of the economic factors which frequently demand consideration in passing judgment upon important industrial undertakings, it appears that there is little danger of including too much study of economics in engineering training. It has been pretty well demonstrated that in order to become a safe engineer the technically trained man must first be a good business man.

CONSOLIDATION AND EXPANSION OF COURSES

In the development of engineering courses there are two dangerous extremes which most technical schools endeavor to avoid. Tendency toward these two dangers is a natural consequence of the institution's struggle to crowd the maximum quantity of information into a student in the minimum length of time. This is usually a more serious problem for state institutions, on account of the misdirected and ill-advised political pressure which is sometimes brought to bear upon the governing authorities of the institution. A common example is the school that is compelled to receive the poorly prepared product of the average high school and transform him into the making-of-an-engineer within a period of four years' technical training.

The struggle to meet this condition, and at the same time keep pace with developments in practice, frequently results in the undue expansion of certain courses of study until a definite quantity of useful knowledge is spread out in a thin layer over a considerable period of time. Frequently in this development the apparent improvement in one course is accomplished at the expense of another. A standard and well-balanced course may be forced to concentrate until the time allotted thereto becomes inadequate for the thorough presentation of fundamental principles. This

process may result on one hand in dilation which is nothing but dilution, and on the other hand in concentration which degenerates into a smattering.

DANGER OF EXTREME SPECIALIZATION

Another struggle between two tendencies is frequently apparent in technical schools, viz., either to produce a jack-of-all-trades who has studied at so many different subjects that he has no useful working knowledge of any, or to develop in some one line of investigation such a highly specialized product that his general usefulness in the world is confined within very narrow limits.

It is frequently said that we live in an age of specialization. This is true, but the remark contemplates specialization within sane limits. In this connection it may be fair to observe that the average high school graduate who elects to attend a technical school is usually more mature mentally than the one who decides to follow a liberal arts course. One has decided upon his profession, or has at least determined the general line of activity for which he is best fitted, while the other is still wavering, and may not yet have developed any definite ideas or ambitions as to his probable future career.

This observation by no means assumes that the man who has tentatively chosen his profession is the more intellectual of the two, nor does it assume that he is correct in his estimate of his fitness for the work he has chosen. He may be utterly lacking in certain characteristics which go to make up a successful engineer. A man does not always find his best opportunities in the special vocation which he has chosen. Frequently a technical graduate who has devoted much effort to a certain line of endeavor, and has gained valuable experience therein, finds himself face to face with an attractive opportunity for growth and expansion in some radically different occupation, to say nothing of possible commercial advantages of such a change of labor. This case suggests the advantage of developing in the technical student, so far as possible, a degree of versatility which will relieve him of the necessity of depending upon a single accomplishment for his professional usefulness or advancement.

A frequent danger of specialization, especially in engineering professions, is for the student, and later the engineer, to become what is commonly called narrow. During the intensive study of technical and scientific subjects the student may have absolutely neglected his non-technical education, to his ultimate serious disadvantage in most cases. Usually little or no time is provided for the further study of English or other modern languages, no effort is made to develop ability in technical writing or in business correspondence. The idea that a technical man has a right to acquire a taste for good literature, or that his general cultural development is likely to have a vital influence on his professional career, is frequently ignored in designing a curriculum. Certainly it is a fact that the advantages of developing in an engineer those qualities which are associated with ideas of culture and refinement are seldom even thought of, at least by the student who must later on suffer because of this neglect. Most interested observers can recall more than one case of an engineer who is thoroughly competent in certain technical and business activities, but who is severely handicapped

and misjudged because he appears to be positively illiterate.

PREPARATORY SCHOOLS DEFICIENT

A young engineer's ability to seize and make the most of his opportunities may be due to the training he received in high school, where certain tendencies, or habits of thought, or fundamental qualities or ideals were developed and cultivated. Right here in the high school is one of the most important periods of a young man's education. For the student who intends to go to college or university it is of vital consequence. While the high school is in many respects the most important link in our educational system, it is at the same time the weakest. The average high school throws away its opportunity. Lucky is the technical man who has learned in his high school course how to speak and write his native language correctly and has mastered elementary mathematics, physics and chemistry. Many an engineer owes his cultural accomplishments and his taste for good literature, which are a never ending source of satisfaction and advantage, entirely to his high school instruction. Unfortunate is the technical school man who has been denied the refining and broadening influence of an efficient high school course. Few technical schools have time, or take time, to supply the kind of instruction and training that marks their graduates as men of liberal education.

Observation of modern tendencies in high school instruction is not reassuring to the seriously interested critic. During the past fifteen years or more almost all high school courses, which were formerly calculated to prepare the student for university training, have sadly degenerated. High school teachers of long experience, who are disposed to be frank in the matter, admit this to be true. There is a growing disposition to let down the former standards to the extent that the university finds it necessary to devote undue time and attention to the review of many subjects which should have been mastered in a preparatory school. This degeneration appears more serious when we realize that a large proportion of young Americans never complete or pass beyond their high school course, and that with deficient instruction the high school is losing its last opportunity to impart valuable knowledge to future citizens. High schools seem to have developed a policy of graduating the greatest possible number without regard to quality of work. To some extent this policy is forced upon the high school by the tax-paying public which demands that the school increase its sphere of usefulness by imparting a little more knowledge to a great number of future citizens. The so-called vocational training movement has done much to lower the general quality and standards of high school instruction, and to diminish its usefulness as a preparatory school for those who contemplate higher education. This observation is not intended to imply that vocational training in the high school, and its effort to turn out more graduates of poorer average quality is wrong from every viewpoint. If we adopt as our guiding principle "the greatest good to the greatest number," then the modern tendencies in high school instruction may be admirable in theory. Advocates of this principle point out that relatively few high school graduates go to the university, and hence it is unfair to regulate high school standards for the benefit of the

minority. There is little consolation in this argument for those who do contemplate higher education, and the suggestion is made that these students should receive separate or supplementary instruction calculated to supply their needs. While it may be admirable to increase the number of slightly better educated citizens by designing high school instruction to fit their requirements and capacities, it is also important to look to the welfare of that less numerous class that continues its development, and from which many of our leaders of thought are destined to be chosen.

CONCLUSIONS

The above informal and somewhat rambling observations lead naturally to the conclusions reached by Professor Hill. All of his eight conclusions are interesting and worthy of careful consideration, not only by designers of technical curricula but also by those who have power to influence the efficiency of the preparatory school training. Preparatory schools should give most serious attention to his conclusion No. 5, which states: "Readjustments in preparatory and earlier secondary school training are desirable so that preliminary training may be completed earlier. This will save time below and gain time above." In other less elegant words, our educational system would be greatly improved if the average high school would do its duty and quit "passing the buck" to the university. Again, the technical school should take to heart his conclusion No. 8, which is in part: "Non-technical instruction for technical students must be as efficient as technical instruction." It is to be hoped that technical schools will interpret these words to mean that it is worth their while, from selfish as well as altruistic motives, to make every reasonable effort to produce "well-informed business gentlemen" rather than "crude skilled technicians."

HARRY J. WOLF.

Denver, Colorado.

Origin of the Nebraska Potash Lakes

To the Editor of Metallurgical & Chemical Engineering

SIR:—The very evident interest which the chemists of the United States are bestowing upon potash products and the importance of the Nebraska Lakes has emboldened me to write you a somewhat geological letter dissenting from the usual views held as to the source of the solutions in the saline lakes which are now providing the bulk of this country's available potash. This question is of great importance, since the accepted views set forth in your recent article on "The Nebraska Potash Industry" (METALLURGICAL AND CHEMICAL ENGINEERING, Vol. 17, p. 673, Dec. 15, 1917) that the lakes are merely concentrations of wind-borne plant ashes, give a distinct limit to the amount of potash available from this source. An intensive study of the sand-hills region and its vicinity has brought so many facts to light which are at variance with this hypothesis that I have concluded that the source of the potash is from ground waters circulating through the underlying sands. If this be true, the amount of available material is enormously greater than possible under the former hypothesis. I base my theory on the following observed facts:

Following the upheaval of the Rocky Mountains were numerous periods of erosion and deposition. The material being eroded from the slopes was carried east-

ward from the divide and deposited in an inland sea covering what is now the High Plains area. The product of this entire period formed rocks and strata in that region which we now term the Tertiary series. There are some fifteen members of the Tertiary, all being conglomerates, varying chiefly in the predominance of lime or silica present. Thus some of them, such as those called the Niobrara by the geologist, are limestones, while the Arikaree and Ogalalla are calcareous sandstones.

As the inland sea receded, erosion of the lake bottom commenced, and the present sand-hill area was formed from these calcareous sandstones by the simple process of the removal of the cementing material by surface waters.

A chemical analysis of the cementing material of the present consolidated strata shows it to consist of a mixture of calcium, iron and aluminium salts, together with high percentages of potash and soda (25 to 30 per cent). These bases are combined in a complex manner as chlorides, phosphates, carbonates and sulphates, and were evidently derived from the original feldspathic granites of the Rocky Mountain uplift.

Since the potash lakes are found chiefly in the area covered by the Arikaree formation, and since this formation has been found to contain the highest percentage of potash of any of the Tertiary, it is reasonable to attribute tentatively the lake deposits to the potash-bearing Arikaree. This is especially reasonable when it is known that the bulk, or sand (aggregate) of the Arikaree consists of orthoclase feldspars containing from 20 to 35 per cent of potassium in the form of potassium aluminum silicate and the cementing material is a mixture of lime, iron, soda and potash salts containing from 10 to 30 per cent of the latter.

Generally speaking, the lakes of the potash area contain about 40 to 60 per cent total alkali, the better lakes running high in potash (25 to 30 per cent), while the poorer, or alkali lakes, contain from 8 to 15 per cent of potash and 25 to 40 per cent of soda. I believe this variation is best explained by the supposition that the latter lakes represent those which are geologically older, or which are in proximity to some well-defined underground drainage course. It is well known that old topography is characterized by well defined drainage courses.

Since the potash salts are generally the most soluble, they will pass into the ground water more readily than the other salts. Hence we have soda lakes in the eastern portion of the sand-hill area where the drainage is quite mature, and potash lakes in the western part where the concentration is in progress.

The lakes are largely supplied by subsurface drainage from the Arikaree formation still *in situ* to the north and west, and from which there is no apparent outlet for these solutions, owing to the lack of any well defined system of creeks and rivers. There are numerous lakes in the catchment area of both the Platte and the Niobrara rivers, but these are fresh water lakes, since the alkali salts are continuously removed by the natural drainage. Surface potash lakes, on the other hand, exist on the consolidated Arikaree tableland adjacent to Alliance, at a considerable distance from either of these rivers. These later lakes represent the period very early in the life-cycle of a potash lake.

W. A. NORRIS.

North Platte, Neb.

Electrolytic Pickling of Steel

To the Editor of Metallurgical & Chemical Engineering

SIR:—In your issue of Dec. 15, Prof. M. De Kay Thompson and F. W. Dodson describe some tests which they made comparing electrolytic pickling with chemical pickling. They used black sheet-iron and found that the surface after electrolytic pickling was "much better" and was "a silvery white and very clean" while that treated by the usual chemical process "was not so clean, but was covered with fine black particles which did not wash off easily but which could be removed by rubbing." On this basis they compared the amount of acid and iron in the final solution and then drew their conclusion.

This is on its very face an unfair comparison and misleads those who may be interested in the process, for it is evident that the chemical pickling had not been carried far enough to remove all the scale, and if it had been there would necessarily have been a much greater amount of acid and metallic iron consumed than they found. To "rub" and rewash the iron in large works would increase the cost greatly, but in their academic tests they entirely neglected this important additional cost.

One of the chief advantages of the electrolytic process is that all these deep-seated "black particles" can be dissolved off without dissolving any appreciable metallic iron and without uselessly consuming the corresponding acid. While with the chemical process the most wasteful consumption of metallic iron and the corresponding acid takes place just when these deep-seated "black particles" are being removed, if indeed the process is carried so far, as that leaves the surface deeply pitted. Had they carried the chemical pickling far enough to remove all the oxide to the extent to which it was removed electrolytically or even only approximately, their consumption of metallic iron and acid would have been far greater.

Moreover, in the chemical process they filtered off the scale so that no acid would be consumed in dissolving it. This is academic, as it is not done in practice and would be quite expensive. While the scale is not directly soluble chemically in sulphuric acid, yet when reduced by hydrogen it becomes soluble; and as the agitated liquor is always full of hydrogen considerable of the removed scale in the bottom of the vat no doubt is ultimately dissolved, thereby consuming additional acid quite uselessly, as the object of the pickling had then been accomplished.

Furthermore their acid for chemical pickling was stronger than what I was informed was used in practice, while for the electrolytic process it was weaker than what it should have been; both give undue favor to the chemical process and are therefore unfair and misleading.

That they did not carry out the electrolytic process properly and therefore got wrong and misleading results, is shown by the very low current densities they used, and it was for this reason that the iron was not sufficiently protected by the current and may have been partly dissolved, thereby also uselessly consuming acid. One of the important features about the electrolytic process is that the high current density prescribed protects the clean iron from being dissolved. I have treated a cleaned piece of iron electrolytically at the

proper current density about fifteen times as long as it takes to clean it and yet found that it had lost practically nothing in weight, while treated proportionately long by the chemical process the sheets would probably have had actual holes eaten through them. Had they carried out the process as prescribed in the patents they should not have lost an appreciable amount of metallic iron. Moreover, the higher current density would no doubt have also reduced the time required; but even so, when the scale was thick they found it took only 8 minutes as against two and a half hours for the chemical pickling.

In a letter to the writer Professor Thompson states: "I think there probably is very little metallic iron dissolved in the electrolytic method, but we did not determine this." Unfortunately his article gives quite the contrary impression. He adds: "Perhaps it should have been stated (in the article) that no attempt was made to distinguish between the two sources of dissolved iron," meaning whether it had been useful metallic iron or useless scale.

They used the lower current density because they claimed to have found the current "efficiency" to have been greater then. This is academic; the current in the electrolytic process is but a small item of the cost, while the metallic iron lost, with the corresponding acid, is a large item.

The commercial man rightly looks after the dollar; to save a little in a cheap item and thereby lose a lot in an expensive item is not good practice, even though it may appear to be better academically.

It is manifestly not fair to the electrolytic process to conclude from the iron found in solution afterwards that this was originally metallic iron, which is certainly the impression they give when they say that "the amount of iron dissolved was 2.88 grams," or such-and-such per cent of the original oxidized sheet. When properly carried out the iron in solution comes from the scale alone, while in the chemical process it necessarily was nearly all good metallic iron, as they say they filtered off the scale which drops off by dissolving the iron underneath.

Academic tests can be very misleading and deceiving when proper consideration is not given to the factors which are of chief importance in the industrial applications.

Some of the writer's tests were described in *METALLURGICAL AND CHEMICAL ENGINEERING* for November 1, 1915, p. 785.

CARL HERING.

Philadelphia, Pa.

Permits for Potash Exploration.—Under a recent law permits may be issued for the exploration for potash on tracts of land not to exceed 2560 acres. These permits run for two years, and if potash of commercial quality and quantity is discovered, the permittee will be given a patent for one-fourth of the land covered by his permit, and the remainder may be leased by the Government to others. Secretary of the Interior Lane recently issued the first prospecting permit under this law, covering 2560 acres of alkaline marsh land in the desert region of Inyo County, California, and the permittee expects to promptly begin explorations by sinking wells. Other similar permits will be issued in the near future.

Western Metallurgical and Chemical Field

Canadian Lead Situation

WITH the resumption of operations at the lead smelter of the Consolidated Mining and Smelting Company at Trail, British Columbia, the Canadian lead situation enters upon a new phase. During the early part of 1917 the 12-cent lead market, and the prospect of dollar silver induced miners in British Columbia to extend their production to the utmost. This ore, sent to the smelter at Trail, soon built up a formidable surplus, receipts during the first week in October amounting to the record quantity of 12,600 tons. By this time the lead market had dropped to 7 cents with a prospect of a further decline, the Canadian market was very quiet, and in order to protect itself the smelting company issued a notice stating that lead ores containing more than 4 per cent zinc would no longer be accepted. Since such action would cut off shipments from practically every independent producer in British Columbia—that is to say, in Canada—immediate pressure was brought to bear upon the government to remove the export embargo then existing on lead ores, which the Dominion government decided to do. The greater freight rates to the Tacoma and other smelters in the United States, together with a 6-cent lead market, did not promise much relief to the Canadian miners, however, but meanwhile the Trail smelter announced that after November first it would accept shipments on the basis of the average shipments of the past twelve months. This action on the part of the smelting company was possible following the receipt of a substantial order from the Imperial Munitions Board, which with other orders on their books would assure normal smelting operations until the spring of 1918.

Shipments had hardly been resumed, however, when a very ill-advised and hasty strike shut down the Trail plant for several weeks, again deranging the economic life of the province. On investigation the International Mine, Mill and Smeltermen's Union declared the plant "fair" and censured the local for violating their agreements, whereupon the smeltermen resumed work under their old sliding-scale contracts at lower wages than before the shut down, the price of lead having dropped meanwhile.

Despite these vicissitudes, the production at Trail was 22,130 tons of lead during 1917, which figure is about 2000 tons in excess of that of 1916. Since Canada is making an effort to be self-contained, at least as far as lead is concerned, the possible disposition of this amount of metal within the Dominion is causing considerable discussion. During the preceding years considerable quantities went into munitions, mostly as shrapnel bullets. However, the large Canadian munitions orders early in the war were financed by the Imperial Treasury, as pointed out by Alfred Stansfield in the December bulletin of the Canadian Mining Institute. Since those days Great Britain has been able to increase largely the production of her own factories, and the lack of funds has made it necessary for her to order supplementary material from countries which can loan her enough money to pay for them. Hence the further production of Canadian munitions consuming lead must be financed by Canada herself, and it would require

shrapnel worth twenty million dollars to absorb the 10,000 tons of lead annually produced in Canada in excess of her normal peace requirements. Even this material after manufacture may be impossible to ship through the submarine zone, and Prof. Stansfield feels that a more rational outlet for the excess lead is as lead compounds or to replace those lead articles now imported. Before the war Canada consumed annually 30,000 tons as metal and in compounds, while its annual production amounted to but 19,000 tons. While imports of white lead are constantly decreasing, in view of the growth of the Canadian corroding industry, much litharge is still imported and could easily be made locally. The manufacture of sheet lead, lead pipe, and other like products is also a possibility, but only if the Canadian market is assured.

Nebraska Potash Production

As a general proposition it is safe to say that the Nebraska fields have not produced the expected amount of potash during 1917. One plant fell short of its estimates at least 1500 tons due to a variety of causes—labor difficulty, fuel shortage, and the extreme cold weather which cut down the efficiency of the evaporating plants enormously.

The outlook is good for a larger production during 1918, however. Three new plants are in course of construction at Antioch. One owned by the Alliance Potash Company expects to begin operation in May. The other two will doubtless make strenuous efforts to start before the next winter sets in, and they may contribute materially to the total for the year. Building is necessarily slow, owing to the great difficulty in obtaining materials and evaporating equipment. In fact, it is almost impossible for operating concerns to procure certain classes of supplies, such as valves, for instance, and these things are ordinarily rebuilt in their machine shops in order to keep the plants running. Since most of the nearby lakes have been drawn from, the newer plants will face a question of piping the brine long distances.

Shortly after the Government took over the control of the railways extreme difficulty was experienced in getting a supply of oil and coal, but these matters are better adjusted at present, and regular shipments of coal are being received. The oil situation is still causing the operators much uneasiness, the Standard Oil Co. not being able to give assurance about deliveries as to time or quantity. Consequently, fuel oil necessary for the operation of the rotary driers has been shipped from as far as Texas, making the cost almost prohibitory. The labor situation has been better this winter than at any other time since the development of the lakes, cold weather may have an important effect on keeping the floating labor stationary, however.

New Smelter in Arizona

The United Verde Extension Mining Company is constructing a new smelter on a site near the Verde River, about three miles south of Clarkdale, Ariz., where the older plant of the United Verde is situated. The copper ore will be milled to the lowest levels of the mine, which is situated at Jerome, and hauled by standard gage equipment through a haulage tunnel and thence over a private railroad to the smelter bins.

The plant will consist of six roasting furnaces, two reverberatory smelting furnaces, one blast furnace and

three converters. It has been designed with especial attention to future extensions; any part can therefore be enlarged without interfering with the operation of the previously completed portions.

The roasting plant is similar in detail to those now in operation in the most up-to-date smelters in the southwest, the general features of which have already been described by the designer at the Arizona meeting of the American Institute of Mining Engineers.* The furnaces are of the Wedge type, each having its own motor drive.

The reverberatories will be 25 ft. wide and 120 ft. long, and will be fired with pulverized coal. From an improved type of car, the calcines will be dumped into large bins above the firing end of the furnace, from which they will be drawn by scraper conveyors along each side of the furnace, and charged by means of pipes through the furnace roof at intervals of approximately 30 in. along the skewback.

The blast furnace will be 48 in. by 320 in. in size. Coke and ore bins will be placed on either side of the furnace above the charge floor. These bins will be filled by conveyors from supply beds, and will be drawn off into electrically operated charge cars.

The converters will be of the Great Falls type, 12 ft. in diameter, and served by a 40-ton crane. Silica will be charged through conveniently located spouts leading from bins placed above and to the rear of the converters. These bins will be filled with crushed flux by means of suitable belt conveyors.

It had been the intention to start the smelter on April 1, but numerous delays in delivery of material will probably set the date a few weeks later. A. G. McGregor, of Warren, Ariz., is the designer of the plant, and Barry Hogarty is Superintendent for the United Verde Extension Mining Company at the smelter site.

By-Products from Colorado Smelters

In the report of the Colorado Smelter and Ore Sales Investigating Committee, the following statement is made relative to the recovery of by-products at Colorado smelters:

There are two smelting plants in Colorado equipped with baghouses for the recovery of the volatized material from the blast furnaces. That portion which is volatized in the roasting of the ore is not recovered at any Colorado plant.

In addition to the recovery of gold, silver and lead from the flue dust and baghouse product, arsenic and cadmium are recovered at the Denver plant. The arsenic plant at Denver treats the flue dust and baghouse product from all company plants. The maximum output of the plant is 120 tons per month of arsenic trioxide.

The cadmium plant at Denver treats the baghouse product supplied from various smelting units of the company, many of which are operating outside the state. The maximum output of this plant is four tons per month.

A small quantity of bismuth was produced from the Leadville plant.

The production of these by-products is the result of the concentration and accumulation of the material treated. With the exception of possible special occur-

rences, these metals are probably associated with others, and the quantity in the original is so small that the extra expense of its recovery from the crude ores would not be justified, and no accounting is made of their value in the purchase of the ores for the smelters.

Arsenic and bismuth are usually found in combination with sulphur, and cadmium accompanies zinc, and they are all susceptible to high loss from volatilization.

Rapid Growth of American Magnesium Industry

WHEN the European war started, practically all of the magnesium used in this country came from Germany. It soon, however, practically disappeared from the market here and the price soared up to a prohibitive figure so that many manufacturing concerns discontinued its use. It is now being made in this country in comparatively large quantities and the price has now been reduced and is approaching that which was general before the war. It is being sold in small lots for not over \$2.00 per pound and in large quantities very considerably below this figure.

According to a preliminary report just issued by Frank L. Hess of the Geological Survey, four American firms were responsible for all the production of magnesium in the United States in 1916—75,400 lb., valued at \$311,570. In 1917 five firms produced 115,800 lb., valued at \$233,600. In spite of an increase of 65 per cent in quantity there was a decrease of 25 per cent in value, for the average price fell from \$4.13 a pound in 1916 to \$2.10 a pound in 1917. The price early in 1916 reached \$5 a pound. Late in 1917 it fell to \$1.85 a pound.

In 1916 magnesium was made by the Electric Reduction Co., Washington, Pa.; Norton Laboratories (Inc.), Lockport, N. Y.; Rumford Metal Co., Rumford, Maine, and General Electric Co., Schenectady, N. Y. The Electric Reduction Co. has found it more profitable to use its power for other purposes, but the other companies named produced magnesium in 1917. The American Magnesium Corporation, the successor of the Aviation Materials Co. at Niagara Falls, made an output in 1917, and the Dow Chemical Co. began production at Midland, Mich., but was prevented from operating at its full capacity by shortage of coal. The General Electric Co., which in 1915 had been forced to make magnesium in order that it might have the metal it needed for its own work, closed its plant in 1917, as the industry is now well established in this country and the price has fallen to a point near that which prevailed before the war.

The Rumford Metal Co. and the American Magnesium Corporation have investigated and produced alloys of magnesium with aluminium, calcium, copper, iron, nickel and silicon. The latter concern is producing an alloy containing 50 per cent magnesium and 50 per cent copper and an alloy containing 20 per cent magnesium and 80 per cent copper. The company has furnished us with the following information concerning these alloys:

"For use as a deoxidizer and scavenger in copper, brass, bronze and phosphor-bronze castings.

Magnesium in small quantities, in copper, brass and bronze castings, has a beneficial effect, making the metal close grained and having superior physical properties. In phosphor-bronze, an excess of magnesium produces pin-

*This journal, Sept. 15, 1916, p. 329.

holes and other imperfections in the castings but a small quantity results in much improved metal.

Use a small quantity of magnesium, of about 0.05 per cent, which is amply sufficient for deoxidizing purposes. Probably one-half of this quantity will give even better results in alloys containing zinc, such as brass or bronze, for the reason that there is less oxide to be reduced than in metals like copper or nickel.

Magnesium is, theoretically, a better deoxidizing material than a non-metal like phosphorus. This alloy should be used in copper castings, where high electrical conductivity is desired. It is prepared simply to facilitate its use in the foundry, as magnesium alone is very light and floats and burns on the surface of molten copper and brass unless special precautions are taken to keep it submerged.

One of the principal uses of magnesium is for alloying with aluminium for airplane parts, where lightness is important. By the proper combination of magnesium, aluminium and other metals, in small quantities, an alloy can be produced which will reduce the weight nearly one-half below the weight of No. 12 aluminium. Magnesium is being used more and more as a deoxidizer and scavenger for copper, brass and bronzes and a new alloy of magnesium has been prepared for use as a deoxidizer and scavenger for high grade tool and alloy steels. Another large use of magnesium is in the powdered form for light bombs and flares for lighting night attacks on the European battlefields.

The following references to the use of magnesium have been kindly furnished us by Mr. I. R. Edmands, president of the American Magnesium Corporation:

Brass and Bronze.—An excess of magnesium can be used in deoxidizing without working harm.¹ Usually 0.05 per cent in the case of brass is sufficient. 0.05 per cent increased tensile strength of brass 30 to 50 per cent. 0.05 per cent increased tensile strength of bronze 25 per cent. Elongation increased 40 per cent in both cases.

Copper.—Copper refined in the following way was found equal to the best electrolytic copper.² The copper charge is melted in a graphite crucible and the oxides reduced by the addition of 0.1 per cent magnesium in the form of a copper-magnesium alloy containing 20 per cent magnesium. A bi-silicate slag is useful as a solvent for the MgO. Magnesium may be employed for removing the last traces of oxygen from copper that has already been partly refined in the usual way.³ An excess of magnesium over that necessary to combine with the oxygen must not be used. The copper should be covered by acid slag, or a boric acid flux, with which the MgO will combine. Magnesium is the most satisfactory agent for the deoxidation of copper according to Sperry.⁴ The magnesium in the form of bars is alloyed with 90 per cent copper before introducing it into the melt so that it will not float on top. The Mg-Cu ingot is stirred into the metal with a plumbago stirrer. A great advantage of the magnesium is that it decomposes the gases occluded in the melt as well as combining with the oxygen. Thus, CO, which is present in larger proportions than any other gas, is reduced to carbon.

Magnesium-Aluminium Alloys.—An alloy of the following composition has been patented by Chemische Fabrik Griesheim-Elektron:⁵ Magnesium 92 per cent; aluminium 8 per cent. Specific gravity 1.75. Strength equal to that of gun metal. The presence of a small

quantity of magnesium in aluminium hardens the latter very considerably according to Wilson.⁶ Microscopical examination reveals no change in the structure of the metal. The hardening of the metal is accomplished by heating to 500 deg. C., quenching in water and allowing to stand. This hardness develops gradually, as well as an increase in strength and ductility. The metal should not be worked directly after hardening. Heating to 200 deg. C. after this treatment causes a distinct loss of hardness. In the manufacture of magnesium-aluminium alloys according to Klaudy⁷ it is of importance that the metals be pure. 10 to 30 per cent magnesium gives an alloy of great strength and easy to work. 2 to 10 per cent produces one that is easy to draw and to roll. Heavy metals can be added to the alloy in such quantity that the resulting density is not greater than that of aluminium. He gives 2 to 5 per cent magnesium as best for wire drawing; 5 to 8 per cent magnesium as best for rolling, and 12 to 15 per cent magnesium as best for casting (pouring). In making alloys of magnesium and aluminium,⁸ the aluminium is melted in a graphite crucible and a small amount of cryolite added as a flux. The magnesium is introduced and held beneath the surface with tongs. The average strength of cast 10 per cent magnesium alloy is 20,000 lb. per square inch. Such an alloy possesses an unequaled lightness, the hardness of brass and the strength of cast iron. An alloy recommended for automobile and airplane construction has the following constitution:⁹ Aluminium 70 to 90 parts, magnesium 5 to 18 parts, cadmium 2 to 12 parts.

It is most likely that the extent to which magnesium is used will depend on its selling price, and many new uses will undoubtedly be found as the price decreases. We have only to refer to the interesting history of aluminium to obtain an idea as to what is possible with magnesium if it can be produced at a low enough price.

¹A. Wilm, *Metallurgie*, 8, p. 225.

²J. K. Klaudy, *Ch. Ztbl.*, 1910 (1), p. 245.

³Brass World, 3, p. 57 (1907).

⁴Brit. Pat. 22,073 (1903).

Status of "Non-Essential" Industries

The Fuel Administration has worked out a plan which provides, in part at least, for necessary restrictions with the least possible injury to industries. This plan provides for fuel curtailment by voluntary agreement among representatives of non-war industries. The effect will be to limit production and make a corresponding saving in transportation and in materials needed for the war. The plan has been tried extensively enough to prove its practicability.

Nevertheless there may be need for more than voluntary co-operation, and for that reason the War Industries Board should immediately list those industries which, as war measures, are of *exceptional importance*. It should determine also, after due notice and hearing, which are the less important industries, measured by the extent of their contribution toward winning the war, and should then announce its findings and enforce plans which will (1) stimulate the operation of industries of exceptional importance, and (2) curtail the operations of the less important, or preferably encourage them to so change their operations as to produce war needs. These are unofficial views of a representative of the War Industries Board.

⁵Brass World, 4, p. 226 (1908).

⁶F. Hueser, *Metall. u. Erz.* 10, p. 479.

⁷Brass World, 9, p. 286 (1913).

⁸E. S. Sperry, *Brass World*, 1, p. 43 (1905).

⁹U. S. Patent 965,485 (1910).

Platinum Industry Under Government Control

THE production, refining, distribution and use of crude and refined platinum was placed under government control March 1, 1918, for the period of the war. The Council of National Defense has issued a statement on the subject which says that the control will be exercised through the chemical division of the War Industries Board. The chemical division has sent out to the industry requests for inventories of the existing stock of crude and refined platinum and platinum-iridium alloys as of March 1, 1918.

The letter stated that it was not the intention of the government to take over and handle directly the present stock of platinum but to permit its shipment by the producers or dealers subject to certain conditions.

Upon the fixing by the Secretary of War of a reasonable price for crude, refined and alloyed platinum, notice will be given and blanks issued governing delivery and distribution.

The letter sent out by the chemical division includes the following directions to producers:

"1. That producers, refiners and dealers in platinum continue to dispose of their product for government purposes, and for that only, as directed by the chemical division.

"2. That producers, refiners and dealers in platinum who are also consumers use platinum for government purposes, and for that only, as directed by the chemical division.

"3. That all obligations arising out of transactions in the production or delivery of crude, alloyed or refined platinum released as above, including all claims for shortage, poor quality, damage or loss in transit, be borne by the producer or seller, as the case may be, in accordance with existing trade practices.

"Distribution may be made by consent of this board through agencies under existing arrangements, provided that there results no increase over the existing price to the user.

"The undersigned, on separate application in each case, will consider permitting the delivery of a limited amount of platinum for essential commercial purposes not for government account.

"Proper blanks upon which application for release of shipment should be made will be furnished on application.

"The following list indicates, in general, the order of preference which will be followed in releasing platinum for shipment: First, military needs of the United States Government; second, military needs of allied governments; third, essential commercial purposes."

* * *

A supplementary notice sent from the Council of National Defense states that in issuing Ordinance Requisition No. 510, commandeering crude or raw platinum now in the hands of importers or refiners of this precious metal, it is to be understood that this commandeering order does not apply to or interfere with the purchase by the consumer of any manufactured articles containing platinum.

This explanation is made so that the public may clearly understand the purpose of this action by the government.

Water-Power Hearing at Washington

THE week of March 18 will be devoted by the joint water-power committee of Congress to hearings on the provisions of the so-called Administration Water-Power bill. The main features of this bill have been set forth in previous issues of this journal, but are briefly reviewed here together with some amendments which have been suggested by the Secretaries of War, Agriculture and the Interior.

The bill is proposed as a House substitute for Senate bill 1419, known as the Shields bill, which was passed by the Senate in the last Congress. It provides for a Federal Power Commission, for the improvement of navigation and the development of water power. The Commission is empowered to issue licenses

"for an original period of fifty years, unless a shorter time is agreed upon between the applicant and the commission or is necessary in order that licenses for parts of the same project shall terminate on the same date. Licenses for subsequent periods of such duration and under such conditions as may be prescribed by then existing law and regulations shall be tendered as provided * * * unless and until at the termination of the original, or of any subsequent period, the properties are taken over and compensation made as provided * * *."

An annual charge of not less than 10 cents per horsepower per annum is to be made and paid into the United States treasury. The funds thus accumulated are to be divided for the construction and maintenance of roads in national forests, for the improvement and development of national parks and monuments, maintenance and operation of dams, etc.

The recapture by the government of any projects developed under the terms of the bill may be effected by paying the net investment of the licensee. Net investment is thus defined:

"'Net investment' in a project means the actual legitimate original cost thereof as defined and interpreted in the 'Classification of investment in road and equipment of steam roads, issue of nineteen hundred and fourteen, Interstate Commerce Commission,' plus similar costs of additions thereto and betterments thereof, minus the sum of the following items properly allocated thereto, if and to the extent that such items have been accumulated during the period of the license from earnings in excess of a fair return on such investment: (a) Unappropriated surplus, (b) aggregate credit balances of current depreciation accounts, and (c) aggregate appropriations of surplus or income held in amortization, sinking fund, or similar reserves, or expended for extensions or betterments. The term 'cost' shall include, in so far as applicable, the elements thereof prescribed in said classification, but shall not include expenditures from funds obtained through donations of States, municipalities, individuals, or others."

If the project is not recaptured by the United States or by a new licensee,

"the terms and conditions imposed upon the original licensee in any new license tendered shall not be such as to impair the net investment of the licensee in said project or projects."

Intrastate rates and service are to be regulated by state commissions charged with such powers. Interstate rates and service are within the jurisdiction of the federal power commission.

It is understood that the hearing is to be brief and to the point. The general features of water-power legislation have long since been threshed out, and what is now needed is a final agreement on the broad aspects of the bill. Criticism should be confined to constructive comment on the more important factors and should not extend to petty, relatively unimportant details.

Fertilizer Industry Under License

UNDER a proclamation recently issued by President Wilson the importation, manufacture, storage and distribution of fertilizers and fertilizer ingredients are placed under license and are required to obtain license before March 20 in order to continue business. The following commodities are affected: Fertilizers and fertilizer ingredients, including sulphuric acid, phosphate rock, acid phosphate, bones (raw, ground or steamed), bone black, basic slag, sodium nitrate, ammonia sulphate, cottonseed meal, slaughterhouse tankage, garbage tankage, castor pomace, fish scrap, base goods, cyanamid, calcium nitrate, dried blood, acidulated leather, hair, hoof meal, horn dust, ground leather, other unacidulated ammoniates, potash salts, cement dust, blast-furnace dust, kelp ash, kelp char, dried kelp, wood ashes, cottonseed hull ashes, potassium nitrate, tobacco waste, mixed fertilizers, sulphur, and all other fertilizers and fertilizer ingredients.

The order does not apply to companies to which licenses have already been issued under the proclamation of the President of Jan. 3, 1918, relating to ammonia, ammoniacal liquors and ammonium sulphates. The Secretary of Agriculture is empowered to carry the act into effect. Licenses are issued through the Law Department, License Division, U. S. Food Administration, Washington, D. C.

Delaware Chemists Discuss Manufacture of Nitric Acid

The second meeting of the recently formed Delaware Section of the American Chemical Society was held at Hanna's Café in Wilmington on Friday evening, March 8. An address was given by Dr. Edward Hart of Easton, Pa., on the "Manufacture of Nitric Acid." Dr. Hart is director of the Hart Laboratories of Easton and was formerly head of the chemical department of Lafayette College and president of the Baker & Adamson Chemical Co. He is one of the pioneers in the manufacture of nitric acid and originated the Hart condenser, which is used in a modified form in the majority of nitric acid plants here and in other countries except Germany. An abstract of his address will be given in a later issue. Dr. Charles L. Reese, chemical director of the E. I. du Pont de Nemours Co., was present and took part in the discussion. The meeting was presided over by J. E. Egleson, manager of the General Chemical Co.'s plant at Marcus Hook, the chairman, Mr. Lamont du Pont, being unable to attend.

The Delaware Section is an outgrowth of the Delaware Chemists, a former du Pont society, and the Philadelphia Section. It is already very active and has about 150 members. In the district below Philadelphia, on both sides of the Delaware as far as New Castle, it is estimated that there are 500 chemists in the various chemical, explosive, iron and steel and other plants.

Dr. R. P. Calvert of the Experimental Station of the E. I. du Pont de Nemours & Co. is secretary of the section and F. W. Barker of the National Aniline & Chemical Company's plant at Marcus Hook is chairman of the membership committee. The next meeting of the section will be held on the second Friday in April, at which Dr. Charles L. Reese will give an illustrated talk on explosives.

Presentation of Nichols Medal to Dr. Treat B. Johnson

At the regular meeting of the New York section of the American Chemical Society held at the Chemists Club, March 8, the Nichols Medal was presented to Dr. Treat B. Johnson, professor of organic chemistry in the Sheffield Scientific School of Yale University. The award had been made in recognition of Dr. Johnson's contribution to organic chemistry, particularly in the synthesis of pyrimidines.

Dr. Charles H. Herty, chairman of the New York Section opened the meeting with a statement, in part as follows:

It is a striking fact that in the midst of feverish war preparations, while our minds are filled with death-dealing chemical reactions, we are met together this evening to pay tribute to a quiet worker in the university laboratory, who with infinite patience and consummate skill has accomplished brilliant results in an extremely complex and difficult field of chemical research, that dealing with the fundamental processes of life. I take it as a healthy sign and one presaging great good to chemistry in America that in these days of intense application of science to industrial processes the worker in pure chemistry has been chosen as the recipient of the Nichols Medal.

Under the terms stipulated by its donor, Dr. William H. Nichols, whom happily we have with us to-night in the capacity of leader of the organized chemists of this country, this medal is awarded annually by our Section to the author of the best original article published during the preceding year in the journals of the American Chemical Society. In reaching its decision the committee has construed broadly the conditions of award, realizing fully that in certain lines of research results cannot be withheld indefinitely in order to present in one contribution a comprehensive report of an entire investigation. Such action might lead to loss of priority, and would undoubtedly diminish that stimulative effect which follows the publication of definite chapters in the progress of investigation which in its very nature must require years for completion.

On the basis of such broader interpretation of the terms of award the committee has this year unanimously awarded the medal to Dr. Treat B. Johnson, Professor of Organic Chemistry in the Sheffield Scientific School of Yale University. During the past year Dr. Johnson contributed four articles to the Journal of the American Chemical Society. A fair measure of his activity can be gained from the fact that these four constitute the continuation of a series of one hundred and fifty-four contributions in which his name has appeared as author.

Through this multitudinous array of original communications Dr. Johnson has shown his courage and ability in bringing light into one of the darkest and yet most important fields of chemistry. In reading the advance copy of his address, and noting the brilliant progress he has made through calling the element sulphur to his aid, I am almost forced to describe his activity as devilish. Beginning in 1898, the output of papers from his laboratory has been continuous—two decades of accomplishment to which we all join in paying heartiest tribute.

We are interested to-night, however, not only in the scientific achievements but in the personality of the man whom it is our privilege to honor. Like so many other great Americans, he was born "down on the farm," near Bethany, Conn., on March 29, 1875. In 1898 he graduated from the Sheffield Scientific School with the degree of Ph.B., and three years later received his doctorate from Yale University, having specialized in organic chemistry. A laboratory assistant during his post-graduate course, Dr. Johnson was in 1902 appointed instructor in chemistry in the Sheffield Scientific School. In 1909 he was promoted to an assistant professorship, and in 1914 was advanced to professor of organic chemistry.

It now becomes my pleasant duty to present to you Dr. William H. Nichols, president of the American Chemical Society, who in his life has taken part in many presentations, and who I am sure will sanction the statement that in no similar occasion has he taken greater pleasure than in this.

In presenting the medal Dr. Nichols facetiously remarked that it had been his pleasure to participate in the presentation of a number of medals, but that he had never been the recipient of any. He declared that "it is easier to give than to receive." After paying a general tribute to the chemists of the United States he expressed a willingness to place his reliance in the American chemist in winning the war and establishing American chemical industry on a sound basis. He said that what he had admired most in Dr. Johnson was not the scientific ability displayed nor the brilliance of the research, but the personal quality which had led him to collaborate with others and permit them to share his honors.

Dr. Johnson expressed his appreciation of the honor conferred and read a paper entitled "The Developments of Pyrimidine Chemistry." This paper is of interest primarily to organic research chemists, as it gives a historical review of pyrimidine chemistry for the past 100 years. It has great importance also for the physiological chemist on account of its bearing on the chemistry of life processes. Dr. Johnson divided his review into historical periods beginning with the discovery of alloxan by Brugnatelli in 1917, and closing with the work of himself and associates in discovering new methods of synthesizing uracil, thymine and cytosine.

War Finance Corporation

A BULLETIN issued recently by the National City Bank of New York contains the following comment on the bill for a War Finance Corporation which has just passed the Senate.

It is generally agreed that the time has come for the government to have control over the investment market, with a view to preventing the absorption of capital and labor in enterprises which are now of secondary public importance, and no doubt there is need for the Government to provide special facilities for financing private enterprises which are engaged in war work or business vital to the general welfare. The plan of the War Finance Corporation is well adapted to these ends. It will be provided with a capital of \$500,000,000 subscribed by the Government, and it will be authorized to issue its own obligations, running from one to five years, which may be sold to the public and the proceeds used to carry out the purpose in view.

We have had nothing but commendations for this part of the plan, but have deprecated the proposal to admit investment securities sold for the purpose of raising more or less permanent capital as the basis of loans and currency issues by the reserve banks. We have done so because we are sure there is no necessity for such action, and have misgivings that the grant of power will create strong pressure for its use, and tend to divert attention from the policy of general restraint upon private expenditures, which we believe to be the true one for this time.

So far as protection of savings banks is concerned we have stated that provision to pay their depositors, if there is any occasion for so doing, is not open to the objection raised against supplying money for industry, for if depositors want their money for the purpose of buying Government bonds all payments to them will come into the Treasury and can be returned to the reserve banks as deposits. It is only as loans are made

in attempts to enlarge the volume of industry, at a time when by reason of natural limitations, it cannot be enlarged, that inflation occurs. Likewise, refunding operations make no demands upon labor or new capital, and, therefore, do not require resort to the reserve banks.

With a close control over the investment market to restrict the employment of capital to approved undertakings, there is no reason to doubt that there will be plenty of capital to meet the important demands contemplated in the bill. At any rate it is certain that no capital can be created by borrowing of the reserve banks at a time when the working forces of the country are already employed to the limit. The point has been reached then when the relief must come by another method—the method referred to by a member of the Federal Reserve Board in a recent address, as follows:

The question which I believe, in view of this situation, the country must soon face, is whether it will be the part of financial prudence for us to attempt to finance our Government loans by an expansion of banking credit with accompanying inflation of prices, or whether it will be better, however drastic the steps necessary to accomplish this result may be, to pursue the course of converting the potential savings fund of the nation into an actual savings fund of sufficient magnitude to absorb the loans of the Government as *savings loans*.*

The pending bill seems likely to become a law without important changes, and will doubtless be administered with great discretion. Our attitude toward the questionable feature has been prompted by apprehension that the public would interpret the measure as providing for expansion, and proceed to manage its private affairs in such a manner that the authorities might be compelled finally by resulting conditions to use the new powers to a degree not contemplated at the outset.

The interpretation which at least a portion of the public places upon the measure was stated by the market reporter of the *Wall Street Journal* after it had been reported to the Senate, as follows:

The economist who argued that eggs now selling at 60 cents a dozen would sell at \$1.50 when the War Finance Bill became a law gave an illustration which the public understands. He may not be exactly right on figures, but the financial district sides with him in his argument. It follows that with commodity prices higher many other things which money can buy, stocks included, may sell higher.

This cheerful view is not confined to the stock market, and probably there are more who hold it than there are who understand that to whatever extent the act has influence upon industrial conditions it will increase the cost of the war and the amount which the Government must raise by taxation and loans.

Coming Meetings and Events

Dyestuff Association of America, Rumford Hall, Chemists' Club, New York, March 6.

American Electrochemical Society, Spring meeting, Southern trip, week of April 28.

American Society of Mechanical Engineers, Worcester, Mass., June 4-7.

American Institute of Chemical Engineers, Berlin, N. H., June 19-22.

American Society for Testing Materials, Atlantic City, June 25-28.

*Address of Dr. A. C. Miller before the American Academy of Political Science, Philadelphia, November, 1917.

Dyestuff Manufacturers Perfect Organization

THE American dyestuff industry was formally organized on March 6 at a meeting held at the Chemists' Club in New York. The chief feature of the meeting was the decision of those present to limit the organization exclusively to American manufacturers of dyestuffs and intermediates. A firm stand on this point was taken by a large majority of the principal manufacturers.

The report of the organization committee, appointed at the preliminary meeting on Jan. 22 was presented by Dr. J. Merritt Matthews, the chairman of the committee. He said the various members of the committee had ascertained from as large a number as possible just what kind of an organization would best serve the interests of our dyestuff industry. The committee after carefully considering the matter then adopted a resolution that an organization be formed to be known as the Dyestuffs Manufacturers' Association of America or some similar name, to consist of manufacturers of dyes and intermediates, and that the dealers form a separate organization, if they so desire.

After the recommendations of the organization committee were presented, a lively discussion took place for and against the inclusion of dealers in the association. Mr. H. G. McKerrow, the originator of the organization and a member of the organization committee, presented a minority report of that committee outlining a plan of organization in which there would be three sections, manufacturers, dealers and allied interests. He was very strongly in favor of including all interests.

When it came to a vote on the subject it was seen that practically all of the manufacturers were in favor of an exclusive organization, and a motion was carried that such an organization be formed. There were not more than half a dozen dealers present and about twenty-seven manufacturers. There were also present quite a large number of representatives of allied interests.

The chief points in favor of an exclusive manufacturers' association were, (1) that dealers' interests will not be essentially American after the war, as they will buy wherever they can; (2) that it has been the experience of other associations that the best results are accomplished by separate organizations connected only through their councils, and (3) that most of the manufacturers are averse to having the dealers included.

The chief points in favor of a mixed organization brought out were, (1) that no sharp line of demarcation could be drawn between manufacturer and dealer as many were both; (2) that small manufacturers are dependent on dealers to market their product, and (3) that dealers are apt to work against the best interests of the American industry unless included as a part of the industry.

The following board of governors was elected to formulate by-laws, nominate officers and take up the other problems, such as the tariff, standardization, etc.: G. H. Whaley, John Campbell & Co.; Dr. Poucher, E. I. du Pont de Nemours & Co.; Alfred Blum, United Piece Dye Works; Mr. Jeffratt, Calco Chemical Co.; August Merz, Heller & Merz; Mr. Orth, Marden, Orth & Hastings Corp.; Frank Hemingway, Frank Hemingway,

Inc.; L. A. Ault, Ault & Wiborg Co.; J. M. Matthews, Grasselli Chemical Co.; Mr. Cottingham, Sherwin-Williams Co.; Robt. Kemp, Read-Holliday & Co.; R. P. Dicks, Dicks, David & Co.; I. V. Stanislaus, Stanley Aniline & Chemical Co.; E. H. Killhefer, Newport Chemical Works.

What the Tariff Commission Is Doing

The following subjects included in the chemical schedule have been undertaken for study by the Tariff Commission and co-ordinated reports of all available information are under way for the use of Congress. Well advanced and subject to early promulgation are: dyes and coal-tar products, sulphur and sulphuric acid, barium compounds, bleaching powder and other chlorine products, citric and oxalic acids, and botanical drugs. In earlier stages of preparation are: lactic acid, thorium nitrate, potash, wood distillation and its products, soap, glycerine and fatty oils, and paints and pigments. Other subjects will follow.

The first study was made on dyes and coal-tar products and this has now progressed so far that it is probable that the first official memorandum on a chemical group of products will be forthcoming within a few weeks' time. We shall reserve discussion until the complete report appears.

A great deal of information has to be asked for because changes are far too rapid to depend upon the U. S. Census; but by friendly co-operation with other departments of the Government much timely information is obtained and the work advanced. A very important report that is in preparation for the benefit of Congress is on the significant changes in chemical industry that have come about owing to the war, with especial reference to changes likely to have a permanent influence on international competition. Work along similar lines is in progress on the metal schedule.

It is hoped that manufacturers and merchants will present their appeals for aid or relief to the commission rather than attempt to spring undigested claims upon Congress at the last moment of debate. The temper of the national legislative body under its great pressure of work is such that neglect to inform the proper authorities of facts bearing upon tariff laws is likely to meet with impatience. Clever dodges are growing exceedingly unpopular.

Native Chinese Industries Discussed at Joint Chemical Meeting

At a joint meeting of the New York Sections of the American Electrochemical Society, American Chemical Society and Society of Chemical Industry held on March 1, two illustrated lectures were given on the native industries of China. Mr. H. K. Richardson, who spent four years in West China in charge of a Y. M. C. A. industrial school, described the production of placer gold, coal briquets, salt, matches, glass, indigo, sugar and tung oil. Mr. C. N. Laird of the Canton Christian College, South China, discussed and showed the primitive processes of making peanut oil and clay products.

Nitric Acid and Copper Ore

By GEORGE C. WESTBY

THE treatment of ores with nitric acid is not commonly resorted to even by the most daring of metallurgists. Occasionally, however, the exigencies of a situation cause the most cautious to look outside the boundaries of established practice, and sometimes a nitric acid process has seemed alluring.

Very little has been published in connection with the quest of those who have departed from the beaten metallurgical track, and sought to utilize nitric acid in ore treatment. This is the story of perhaps one attempt out of many unrecorded ones.

The force of circumstances, the nature of which it is needless to consider, induced an enterprising mining company to give the inventor of one of the nitric acid ore processes an opportunity to demonstrate the commercial value of the process.

Briefly, the method consists in a regulated addition of a batch of ground sulphide ore to warm, dilute nitric acid contained in a Pachuca-shaped vessel, called a digester. The heat developed by the ensuing reaction brings the temperature of the mixture up to around 100 deg. Cent. Steam is admitted to maintain the temperature between 80 deg. and 100 deg. Cent. as the chemical action in the digester gradually fails in energy with the weakening acid.

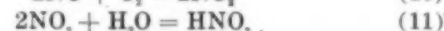
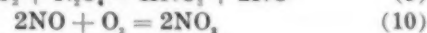
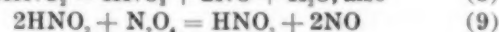
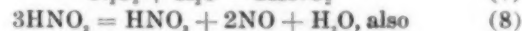
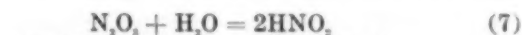
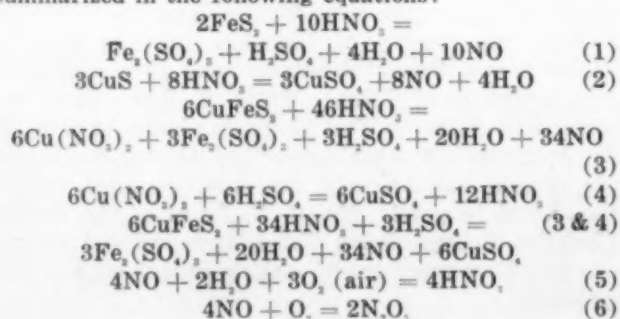
Compressed air admitted at the bottom of the digester agitates the mixture, and also supplies the oxygen necessary for the oxidation of the nitric oxide, which is developed by the action of the acid on the ore, to nitrogen peroxide.

The nitrogen peroxide produced in the digester together with the excess air is forced through a series of quartz-charged absorption towers partly filled with water. This results in the conversion of the nitrogen peroxide to nitric acid, which is again available for the treatment of fresh ore.

Disappearance of the colored nitrogen peroxide from the gases passing to the absorption towers as shown by a glass lantern inserted in the pipe line connecting the digester with the absorption system, marks the practical completion of the action of the acid on the ore. The contents of the digester are then discharged to the washing and filtering system.

CHEMISTRY OF THE PROCESS

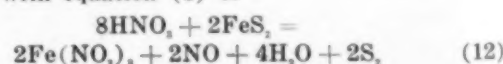
The rationale of the process so far as it applies to the treatment of cupriferous pyritic ores is conveniently summarized in the following equations:



The hypothesis is sometimes advanced that under the conditions of the treatment described it is not necessary to add as large a proportion of nitric acid to the ore as the quantity called for by the terms of equations (1), (2) and (3). The postulate is based on the inference that nitric acid would be largely regenerated within the digester, as the liberated nitric oxide mixes with the air and liquid spume in the space above the reacting ore and acid. It will be seen, however, from results of experiments given below, that this regeneration is insufficient to produce marked effects in extraction of further valuable metal from the ore.

Also with reference to equations (1), (2) and (3), we have illustrated the fact that the material subjected to treatment is preferably a sulphide ore containing sufficient combined sulphur to permit the formation of sulphate from all bases susceptible to attack. Excess of sulphur might be taken up by the addition of an oxidized ore, a deficiency must be remedied by the introduction of sulphuric acid or its equivalent.

Further, in connection with formulæ (1) and (2), the statement might be made that successful commercial application of this form of nitric acid process hinges largely on virtually complete evolution of sulphates in the reaction of nitric acid on the sulphides, for production of nitrates in appreciable quantities involves ultimate loss of this expensive reagent in the discharged tailings and in the solutions discarded from the precipitation system of the plant. An expression for a possible subsidiary reaction occurring simultaneously with equation (1) is



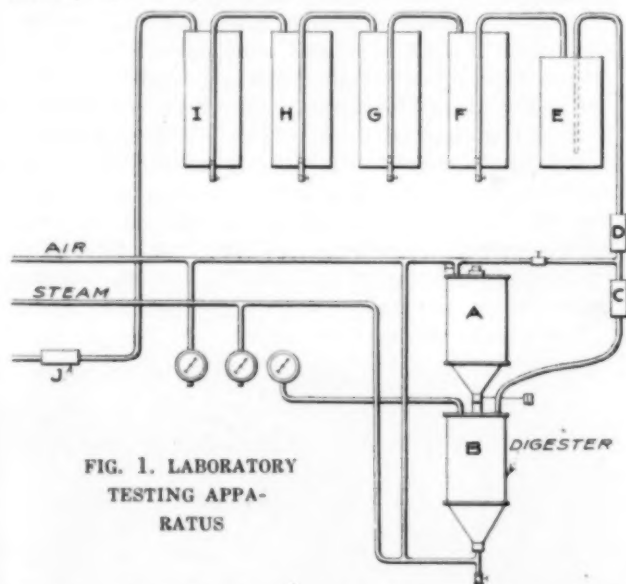
Equations (4) to (9) inclusive refer especially to means of regenerating nitric acid from nitric oxide, air and water, and indicate the circuitous path traversed by a portion of the nitrogen compounds in the formation of nitric acid.

In the absorption treatment it is necessary to keep the cooled nitrose gases in contact with the water and air for at least five minutes, and this implies careful proportioning of the absorption system to the volume of gases we expect to treat. German and English practice has shown that when an adequately large mixing and tower system is provided, practically complete absorption with corresponding recovery of nitric acid is possible; however, even with the use of an end tower charged with an alkaline liquor, it is seldom commercially feasible to obtain a greater absorption than 97 per cent of the nitrose gases passing through the system. The commercial meaning of a 3 per cent loss of nitric acid in a regenerative process using nitric

acid as a solvent for cupriferous pyritic ores, is painfully apparent in estimates submitted in connection with the results of tests given farther on in this record.

EXPERIMENTAL WORK WITH LABORATORY APPARATUS

Preliminary tests on the process outlined were made with a glass apparatus designed to treat two or three pounds at a charge. The apparatus consisted of the parts represented in Fig. 1. *A* is a closed ore-holder provided with a removable top through which ore may be introduced. The digester *B* is situated directly under the holder and the two parts are connected by a short conduit, in which the feeder controlling the flow of ore to the digester operates. Steam and air pipes connected with the bottom of the digester provide means for heating, agitating and oxidizing the mixture charged to the digester. The nitrose gases formed in the digester escape through the exit pipe, the cooling coil and lanterns *C* and *D* to the mixer and condenser *E*, thence, by the pressure formed within the digester



the gases are forced through the absorption towers *F*, *G*, *H* and *I* to the final discharge. As shown by sketch, an air-pipe connection is made between lanterns *B* and *D*. This arrangement provides a means for testing the completeness of the oxidation of NO to NO_2 by comparison of the depth of color when air is turned into the gas stream passing through the lanterns. The gages shown register air, steam and digester pressures.

Many of the results obtained from tests were vitiated by leaks which developed in most unexpected places as the pressure in the apparatus approached 10 lb. gage per square inch; but the tests submitted, in order to illustrate the general possibilities of the process, were selected because no leaks were detected after close inspection of the apparatus throughout the test.

TEST No. 1

Analysis of Ore

	Per Cent
Al_2O_3	2.0
S	29.0
CaO	5.8
Cu	3.6
Fe	26.9
Insol	26.4

The gangue was garnetiferous with calcite present.

Estimation of acid required to treat the ore is based on equations (1), (2), (3) and (4), and consideration of sulphur (or equivalent sulphuric acid) required to sulphatize all the basic elements of the ore.

Assuming all copper in the ore and part of the iron combined with sulphur to form chalcopyrite (CuFeS_2), we have by equations (3) and (4) the factors Cu, Fe, S, HNO_3 and H_2SO_4 expressed in the ratios

$$378 : 336 : 384 : 2142 : 294$$

respectively, which gives when represented in per cent referred to the analysis and weight of the ore

$$\text{Cu } 3.6\%, \text{ Fe } 3.2\%, \text{ S } 3.65\%, \text{ HNO}_3 \text{ } 20.4\% \text{ and } \text{H}_2\text{SO}_4 \text{ } 2.8\%.$$

Considering the balance of the sulphur combined with iron to form FeS_2 , we obtain from the ratios derived from (1) the following expressed in terms of per cent referred to the analysis and weight of the ore:

$$\text{Fe} = (26.9 - 3.2 - 1.52) = 22.18\%$$

$$\text{S} = (29.0 - 3.65) = 25.35\%$$

$$\text{HNO}_3 = 124.53\%$$

$$\text{H}_2\text{SO}_4 = 19.4\%$$

Consequently we require $(20.4 + 124.53) = 144.93\%$ of absolute nitric acid as referred to the total weight of ore to be treated, to decompose the sulphide constituents in accordance with the equations given. Further, assuming the basic constituents of the gangue, such as iron, alumina and lime, to be readily susceptible to the action of the dilute sulphuric acid of the solution, we require for

1.5% Fe a quantity of H_2SO_4 equivalent to	3.9% of wt. of ore
2.0% Al_2O_3 a quantity of H_2SO_4 equivalent to	5.7% of wt. of ore
5.8% CaO a quantity of H_2SO_4 equivalent to	10.2% of wt. of ore
Total	19.8%

Finally then, considering all sulphur shown in the left hand member of the equations discussed, oxidized to sulphuric acid, we require for treatment of

CuFeS_2 a quantity of H_2SO_4 equivalent to	13.97% of wt. of ore
FeS_2 a quantity of H_2SO_4 equivalent to	58.18% of wt. of ore
Gangue a quantity of H_2SO_4 equivalent to	19.80% of wt. of ore

or for sulphatizing all bases equivalent to 91.95% of wt. of ore

The total sulphur present as sulphide in the ore, oxidized to H_2SO_4 would yield a quantity of H_2SO_4 equivalent to 88.74% of the weight of the ore. Consequently we must add $91.95 - 88.74 = 3.2\%$ of weight of ore of H_2SO_4 to complete the sulphatizing of the bases mentioned.

While it is evident that a slight excess of sulphuric acid also might be very useful in completing the dissolution of the ore and accelerating the extraction of the valuable metals, no H_2SO_4 was added in the preliminary tests in excess of that called for by the estimate derived in the manner given above.

In the test under discussion 554 grams of ore was charged to the digester. In accordance with the estimate outlined there should be added 788 grams HNO_3 ,

and 17.73 grams H_2SO_4 . However, only 1500 cc. of 1.24 sp. g. nitric acid was added containing 707 grams HNO_3 . This was to insure maximum regeneration of nitric acid charged to the digester in order to determine the practical effect of possible regeneration within the digester and to neutralize the nitric acid.

General conditions during the test were as follows:

Feeding ore to digester, min.	60
Length of run, min.	94
Gage pressure at start, lb.	8
Gage pressure finish, lb.	10
Average temperature of mixture in digester, °C	64.6
Highest temperature of mixture in digester, °C	77
Lowest temperature of mixture in digester, °C	40
Temperature at finish, °C	56

Nitric acid recovery.	HNO_3 g
In absorption towers	484
In mixer or condenser	185
	669

Nitric acid losses.	
In solution discharged	41
Lost by discharge from absorption towers by difference	7
	48

Per Cent
of Original

Therefore available recovered acid was	93.4
Acid regenerated in absorption system	67.5
Equivalent HNO_3 in solution discharged	5.7
Equivalent HNO_3 lost as nitrose gases	0.9
Cu extraction (allowing for Cu in excess ore)	87.3

TEST No. 2

Analysis of Ore

Al_2O_3	2.0
CaO	8.5
Fe	29.0
S	32.2
Cu	5.1
Insol	21.7

Expressed in terms of percentage referred to the weight of ore, sulphatizing of the bases requires for

	Per Cent S
Copper to form CuSO_4	2.6
Iron to form $\text{Fe}_2(\text{SO}_4)_3$	24.8
Lime to form CaSO_4	4.9
Alumina to form $\text{Al}_2(\text{SO}_4)_3$	1.9
Representing a total of	34.2

Sulphur supplied by ore is 33.2%. Sulphur deficiency to be supplied in the form of H_2SO_4 is accordingly 2.0%, equivalent to 6.1% H_2SO_4 .

Based on equations (1), (3) and (4) approximately 161% HNO_3 is called for in the treatment of the ore.

	Grams
Weight of HNO_3 in 1500 cc. 1.26 sp. gr. acid charged to digester	782
Weight of ore charged	750
Giving an excess of	285

General conditions during the test were as follows:

Feeding 80-mesh ore, min.	44
Length of run, min.	70
Gage pressure, at start, lb.	6
Gage pressure, at finish, lb.	10

Average temperature of mixture in digester, °C	75
Highest temperature of mixture in digester, °C	87
Lowest temperature of mixture in digester, °C	40
Temperature at finish, °C	83

Nitric acid recovery.	HNO_3 g
In absorption towers	509
In mixer or condenser	187
Total	696

Nitric acid losses.	
In solution discharged	51
Lost in discharge from end absorption tower (by dif.)	35
Total	86

Per Cent
of Original

Therefore available recovered acid was	89.0
Equivalent HNO_3 in solution discharged	6.5
HNO_3 lost as nitrose gases	4.5
Copper extraction from ore	89.5

If the equations tentatively given as an expression of processes of this type are substantially correct, we should expect fairly close accordance between the figure representing the percentage recovery of nitric acid and that giving per cent of bases dissolved. It was found that a relationship existed even in tests where an excess of nitric acid was used, that tended to establish the fact that the treatment progresses in general accordance with equations (1), (3) and (4), and that the reaction expressed by (12) is not an important factor in the process.

The results of ten tests gave:

	Per Cent
Average nitric acid recovery	90.5
Average copper extraction	88.9

Some distillation of HNO_3 from the solution is indicated, but the acid brought into the absorption system by distillation cannot be of consequence, since the acid added to the digest is dilute and constantly decreasing in strength as the reaction of the acid on the sulphides proceeds.

In one or two tests excessive agitation projected a larger quantity of undecomposed acid into the condenser. The results of the second test given above are an example of this condition. An appreciable regeneration of nitric acid within the digester should become apparent by relative increase of the figure expressing the percentage of extraction of bases over that showing the recovery of nitric acid, but eliminating ques-

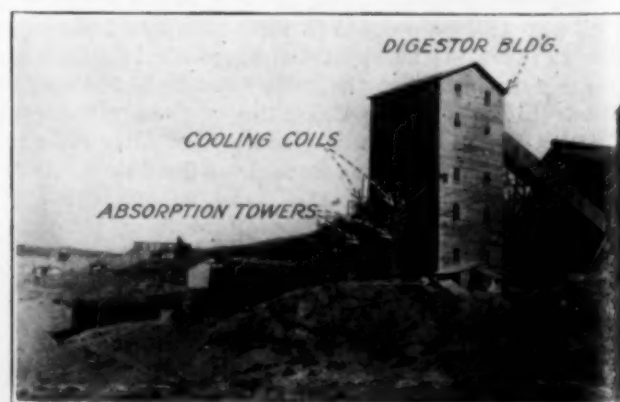


FIG. 2. EXPERIMENTAL UNIT FOR NITRIC ACID PROCESS

tionable results, in no test of the series did the results show a higher figure for extraction of base than that expressing acid recovery. It is conceivable that distillation and regeneration of acid might balance, but in view of the fact that the conditions in the digester do not coincide with the conditions necessary for effective absorption of NO , as given above, and the further fact that the distillation is necessarily small, there is reason for the conviction that regeneration in the digester is inconsiderable.

COMPARATIVE COST OF NITRIC ACID AND LEACHING PROCESSES

Before proceeding with a résumé of results obtained from the application of the process on what was expected to be a fifty-ton scale, we submit comparative estimate of cost between the nitric acid process and one in which roasting and sulphuric acid leaching are the main features of the treatment.

It will be noted that a high recovery of nitric acid is assumed, for it will be seen that a high recovery of acid is necessary if the process is to be considered at all as a commercially feasible proposition.

The cost given for air may seem high, but it is based on actual measurements of the air used in some of the tests and consideration of the air theoretically required as shown by equations (1) and (10).

We have from equation (1) the ratio:

$$2\text{FeS}_2 : 10\text{NO} = 240 : 300 = 1 : 1.25$$

Under standard conditions the weight of one cubic foot of NO is 0.082 lb. (nearly).

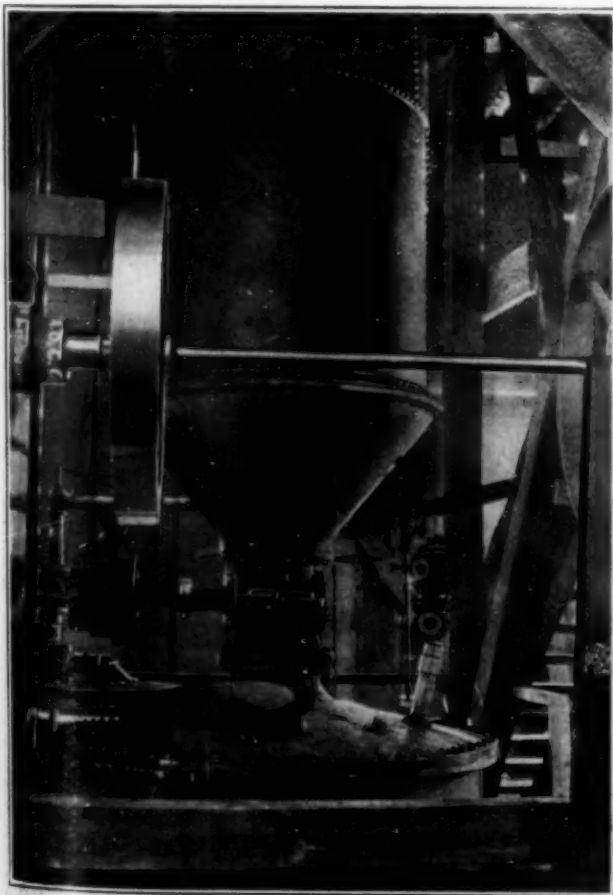


FIG. 3. LOWER SECTION OF ORE-HOLDER, FEEDER DRIVE AND TOP OF DIGESTER

$$\begin{array}{r} 1.25 \\ \text{Then } \frac{\quad}{.082} = 15.24 \end{array}$$

Consequently in theory 1 lb. of FeS_2 develops with HNO_3 15.24 cu. ft. of NO , or at 68 deg. F. (20 deg. C.) and 24 in. barometric pressure, 19.62 cu. ft. NO .

From equation (10) 1 lb. of NO theoretically requires 0.532 lb. of oxygen in forming NO_2 , calling for 2.32 lb. of air, or 48.2 cu. ft. of air at 68 deg. F. and 24 in. barometric pressure.

To compress and deliver 48.2 cu. ft. of air per minute at 30 lb. pressure requires about 4.1 hp., which is explanatory of the cost item for air.

Data assumed in consideration of nitric acid ore treatment.

HNO_3 manufactured at the mine at 3c. per lb.

Loss of $\text{HNO}_3 = 2\%$ of total added.

Copper recovery = 90%.

	Per Cent.
Ore assay, Cu	3.6 = 72 lb. Cu per ton
CaO	5.8
Fe	26.9
Insol	26.4
S	29.0
Al_2O_3	2.0

Estimated cost of treating one ton of ore by HNO_3 under conditions assumed:

Mining 1 ton of ore	\$1.25
HNO_3 , 2% loss at 3c. (58 lb. at 3c.)	1.74
H_2SO_4 to correct sulphur deficiency (64 lb. at $\frac{1}{2}\text{c.}$)	.32
Amortization and interest on plant	.30
Crushing and grinding	.60
Filtration and washing	.10
Air and steam	.50
Labor about digester	.50
Precipitation of copper	.65
Freight, selling, etc. (65 lb. Cu at 2c.)	1.30
	<hr/>
	\$7.26
Credit 64.8 lb. Cu at 15c	9.72

Possible net \$2.46

Data assumed in consideration of treatment by sulphatizing roast followed by H_2SO_4 leaching.

Analysis of ore—given in preceding estimate.

Leaching in tanks by percolation.

Copper recovery, 90%.

Estimated cost of treating one ton of ore by roasting and leaching:

Mining one ton of ore	\$1.25
Roasting	1.00
H_2SO_4 required—300 lb. at $\frac{1}{2}\text{c.}$	1.50
Amortization and interest	.35
Crushing and grinding	.35
Handling tailings, pumping, etc.	.05
Precipitation of copper	.65
Freight, selling, etc. (65 lb. Cu at 2c.)	1.30
	<hr/>
	\$6.45
Credit 64.8 lb. Cu at 15c.	9.72

Possible net \$3.27

The results of the laboratory tests of the nitric acid process were instructive, but unfortunately did not emphatically prove that the process was a striking improvement on methods of ore treatment which it was

designed to supplant. The promoters of the process, however, were of the opinion that the laboratory-scale tests proved nothing of what might be done with larger apparatus. They mentioned achievements in different fields with a large digester, stating also that a 40 per cent regeneration was a common experience with the special type they had worked with; moreover, they owned a complete 50-ton plant ready for installation. The mining company determined to allow the process company to proceed with the erection of their commercial unit.

SUPPLEMENTARY TEST ON LARGE SCALE

The plant was made an adjunct of a dry-crushing mill and was similar in general arrangement to the small laboratory equipment already described. The digester was about 7 feet interior diameter and 14 feet high, and was lined with acid-proof brick set in acid-proof cement. The ore-holder was made of heavy sheet iron and was approximately 12 feet high and 7 feet in diameter. The condensation and absorption system consisted of two 3-in. aluminium coils made up with about 240 feet of pipe, and set in tanks supplied with circulating water; a condenser made from a lined sheet-iron cylinder placed inside a high wooden tank, through which cold water circulated; and a set of five absorption towers, four of which were 16 feet high and about 7 feet in diameter and the fifth in the series 16 feet high and 10 feet in diameter. Pipe connections were made with 2½-in. and 3-in. aluminium pipe and fittings. Solution pipes and fittings were made of duriron. The 1½-in. solution pump used was also made of that alloy.

In operation sulphide ore from the mill was diverted from a conveyor to a small bin situated above the ore-holder. Weighed batches of ore were drawn for each test from the bin to the ore-holder. Nitric acid or a mixture which might consist of a solution of nitric acid, sulphuric acid and nitre was run into the digester from a measuring tank. The solution was then heated by means of steam, which passed into the bottom of the digester through a rubber hose and duriron connections. After the solution had attained a temperature approaching 140 deg. Fahr. air was forced into the digester with the steam and the ore-feeder started.

In presenting the subjoined data it should be stated that the nitric acid was for the most part not added directly to the ore, but was developed indirectly in the solution in the presence of the sulphide ore by means of nitric and sulphuric acid. This method, however, was stated in the patent specifications to be equivalent to the use of nitric acid.

Two of the most successful tests are selected for illustration. The tests were controlled and carried out by patentees of the particular nitric acid process used, the company's representatives making duplicate tests at the same time.

TEST A

	Ore Analysis.	Screen Analysis.	
	Per Cent.	Mesh.	Per Cent.
Cu	2.15	+ 14	0.41
S	16.30	+ 20	6.20
Fe	14.7	+ 30	23.03
Insol	50.4	+ 40	14.80
CaO	5.8	+ 80	23.75
Al ₂ O ₃	5.9	— 80	32.13

General Conditions: Solution heated 40 minutes in digester with steam at 60 lb. pressure. Period feeding ore 143 minutes, the ore being charged intermittently.

Total period of treatment, hr.	5
Ore charged to holder, lb.	4229
Ore left in holder, lb.	980
Actual ore charged to digester, lb.	3249
Ore in excess as figured from HNO ₃ added, lb.	1080

Nitric and sulphuric acids charged to digester:

Per cent HNO ₃ in solution	12.8
Weight of acid solution, lb.	13,860
Specific gravity	1.26
Weight of HNO ₃ in solution, lb.	1774
Weight of H ₂ SO ₄ added, lb.	2217
Weight of H ₂ SO ₄ used for decomposing nitre, lb.	1556
Weight of H ₂ SO ₄ available for bases, lb.	661
Temperature of solution added to digester, °F.	90

(Solution was later further heated in digester.)

Nitric and sulphuric acid required to treat charge:

Approximate weight of HNO ₃ required, based on assumption of complete neutralization of acid by 3249 lb. of ore, in accordance with equations (1), (2), (3) and (4), lb.	2657
Weight of HNO ₃ actually added, lb.	1774
Deficiency of HNO ₃ implying excess ore, lb.	883
Sulphuric acid required for bases, lb.	2174
Sulphuric acid supplied by ore (as S), lb.	1625
Sulphuric acid to be added, lb.	549
Sulphuric acid available in solution charged to digester, lb.	661
Sulphuric acid excess, lb.	112

¹Some free HNO₃ from absorption tower used in these tests.

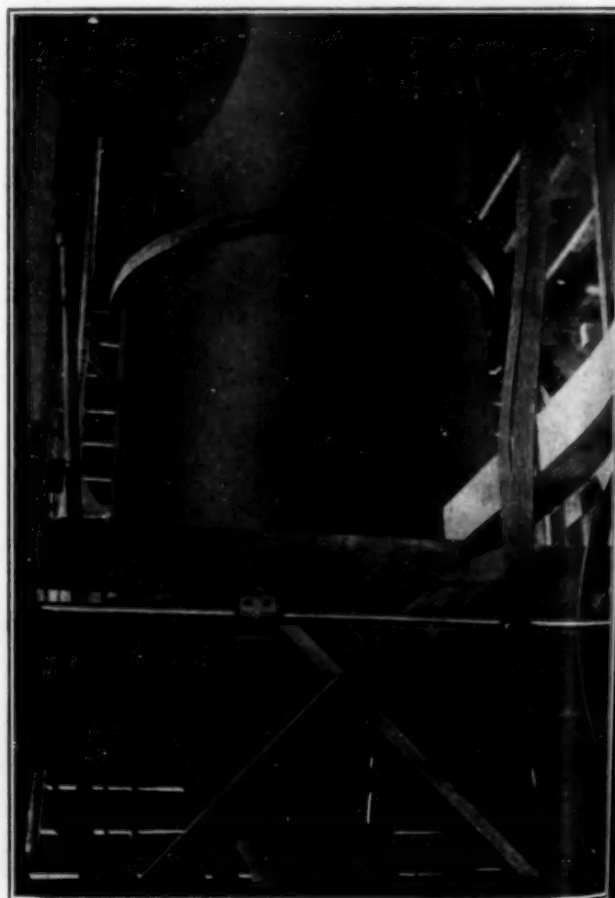


FIG. 4. LOWER PART OF DIGESTER

Nitric acid recovery and losses:

Nitric acid added to digester, lb.	1774
Nitric acid recovered in towers and condenser, lb.	1301
Nitric acid remaining in discharged solution, lb.	437
Nitric acid lost from end tower in form of nitrose gases, lb.	43
Percentage nitric acid recovered from towers and condensers	73.2
Percentage nitric acid in digester discharge	24.3
Percentage nitric acid loss through end towers in form of nitrose gases (by dif.)	2.4

Tailings Analysis:

	Per Cent.
Cu	1.29
Fe	7.8
CaO	3.9
Al ₂ O ₃	4.9
S	7.7
Insol	69.7

Ratio of pulp to solution by weight 1.63.

Extractions:

	Per Cent.
Copper	57.2
Iron	71.4
Sulphur	67.4

Nitric acid recovery in towers plus loss through end 75.7 per cent.

Remarks:

The probability is strong that the difference between 75.7 and 67.4, figures representing total acid driven from digester and sulphur dissolved respectively, is an approximate measure of the quantity of nitric acid either distilled or mechanically carried into the absorption system.

The strength of the discharged solution in HNO₃ was approximately 3 per cent. Action of this dilute solution on the excess sulphide present would doubtless continue, but the action is undoubtedly slow and there is more than a possibility that nitrogen compound such as N₂O may be formed in a large degree, as the acid weakens with sulphides in relative excess; these compounds would not be recovered in the absorption system.

TEST B*Ore Analysis*

	Per Cent.
Cu	2.15
S	15.3
Insol	46.5
CaO	7.6
Al ₂ O ₃	5.3
Fe	15.5

Ore Charge:

Ore charged to holder, lb.	3881
Ore left in at end of test, lb.	2271
Actual charge of digester, lb.	1610

Note: Dry weights are given.

Nitric and sulphuric acids:

HNO ₃ added to digester, lb.	1735
HNO ₃ theoretically required (approx.), lb.	1231.5
Excess, lb.	503.5
Sulphuric acid charged, lb.	1400
Sulphuric acid required for bases and decomposition of NaNO ₃	1372

Nitric acid recovery:

Recovered in towers, lb.	634.1
Recovered in condensers, lb.	93.1
Recovered, total, lb.	727.2
Percentage recovery of HNO ₃ based on theoretical HNO ₃ required	59.1
Percentage recovery of HNO ₃ plus end loss through absorption towers	62.46

Nitric acid losses:

Nitric acid in digester at finish as nitrates and free HNO ₃ , lb.	966.6
Nitric acid in excess of theoretical required, lb.	503.5
Nitric acid figured for treatment of unchanged sulphides, lb.	463.1
Nitric acid lost through end absorption tower discharge as nitrose gases, lb.	41.4
Percentage nitric acid lost through end absorption tower discharge as nitrose gases	3.36
Percentage nitric acid left in digester (of theoretical)	37.54

Discharged Solution:

Weight, 10,174 lb.

Cu = 0.24 per cent = 24.4 lb.

Fe = 1.72 per cent = 175.0 lb.

S = 6.0 per cent = 610.0 lb. 610
457.2*152.8 lb. sulphur
derived
from ore.HNO₃ = 9.60 per cent 19 lb. S approx. left in tailings in combination as CaSO₄*Contents of Original Ore*

34.62 lb. Cu

246.33 lb. S

249.55 lb. Fe

From these results we obtain the subjoined figures:

Extractions:

	Per Cent
Cu	70.5
Fe	70.1
S	69.8
HNO ₃	62.4 passing into absorption towers and condenser

Tailing Analysis:

	Per Cent
Cu	1.74 = 10.22 lb. by diff. which gives 587 lb. tails
Fe	13.3 = 74.55 lb. by diff. which gives 560 lb. tails
Insol	55.8
CaO	5.2
S	14.2 = 93.5 lb.
	3.0 of above combined with CaO

The fact that the figure for extraction of bases is numerically greater than that for nitric acid recoveries (plus the fumes passing through end tower) gives reason for the belief that in this case some copper and iron are in the form of nitrates. And we may suspect the operation of a reaction as expressed by equation (12).

Temperature:

The temperature of the gases passing from the digester varied during active operation between 177 deg.

*Note: 457.2 lb. S added as H₂SO₄ to digester.

Fahr. and 220 deg. Fahr. (thermometer wrapped outside of pipe).

Time:

Minutes preparatory heating digester solution	198
Minutes feeding ore	78
Minutes elapsing between first and last appearance of colored NO ₂	135
Pressure in digester	18 to 20 lb.

Gas:

	Per Cent NO ₂
Entering (average of four determinations)	7.05
Exit (when strong color was apparent at discharge)	2.7

Steam:

Average gage pressure	41 lb.
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The steam heated 10,886 lb. of solution from 70 deg. Fahr. to 150 deg. Fahr. approximately.

Heat added by means of admission of steam was consequently 870,880 B.t.u. (assuming Sp. heat = 1).

Considering 12,000 B.t.u. derivable from 1 lb. of coal—then we have the equivalent $\frac{870,880}{12,000} = 72.57$ lb. of

coal, and allowing for radiation and other heat losses, we have 100 lb. of coal required for preliminary heating of the acid solution.

At ratio of 1:3 = pulp:solution, and assuming cost of coal at \$6 per ton, the figures given indicate a heating charge of about 16c. per ton of ore.

Air:

Assuming 29 per cent of the ore to consist of FeS₂, then from equation (1) we have, by the action of HNO₃, on 1610 lb. of ore, in round numbers 583 lb. of NO. The latter compound in forming NO₂ calls for 311 lb. of oxygen or almost 1355 lb. of air. The volume under standard conditions of 1355 lb. of air is 16,800 cu. ft.

In the test under consideration air was used for oxidation 140 minutes continuously. This would be at the rate of $\frac{15,800}{140} = 120$ cu. ft. per min. under stand-

ard conditions, if the whole of the ore was dissolved in accordance with equation (1) and the whole of the oxygen in the air utilized.

We actually used approximately 414 cu. ft. per minute, which indicates nearly 300 per cent excess over the theoretical of 120 cu. ft.

To compress 414 cu. ft. per minute to 40 lb. by single-stage compression requires about 46 hp. through 144 minutes. This power therefore is necessary to effect the oxidation of the NO derived by the treatment of 1600 lb. of ore, in accordance with the conditions obtaining in the test. Under the same conditions 2000 lb. of ore would call for 69 hp. through 144 min. per ton of ore for oxidation of sulphides.

If power costs are at the rate of 15 cents per horsepower day, these charges for air would be \$1.04 per ton of ore treated in the case under consideration.

Ludwig, Nev.

Metallurgical Renaissance in England.—An announcement from the Institute of Metals (British) states that the last year has witnessed a remarkable growth in the institute's membership—from 660 to over 860. It is expected, in view of the war-stimulated "metallurgical renaissance"—as it has aptly been termed—that the 1000 mark will be passed in the present year.

Rubber and Jelutong

A Review of the Evidence in the Recent Customs House Dispute as to Classification of Gums

BY FREDERIC DANNERETH

A RECENT decision of the Board of U. S. General Appraisers has drawn attention to a matter which has for some time engaged the attention of rubber chemists, more especially since the New York Rubber Conference of 1912. I have in mind an officially recognized, standard nomenclature for terms used in the rubber industry. I believe it was Mr. Frederic Hood of Boston who spoke in favor of this at the time of the conference, and gave the impetus to the later discussions. In 1915 the Rubber Committee of the American Society for Testing Materials recognized the desirability of such a list of official definitions, and a committee was accordingly formed, with the writer as chairman, for the purpose of recording definitions as they are understood in the rubber trade. In 1917 (April 1) this journal presented a tentative list of terms used in the rubber industry, together with definitions for these terms showing the meaning applied to them in the American rubber trade. This list may be considered fairly representative, as it was scrutinized previous to publication by representative rubber importers, manufacturers and their chemists.

One of the deterrents in the situation has apparently been the so-called factor of "good judgment." This, so far as I am able to discern, is a method of buying and selling wherein the seller feels sure that he is selling his merchandise at a comfortable profit and the buyer feels equally confident that he knows more about the goods than does the seller. We have here, as it were, a case of "guess as guess can." This tradition has been applied in a great measure to the problem of definitions for crude rubber and rubber products. Just as this so-called "good judgment" is giving way to laboratory methods of testing the value of raw rubber, so the loose use of terms in the buying and selling of crude and raw rubber is being abandoned. The American rubber industry is most certainly to be congratulated on the progress thus far made in both these problems.

At the annual meeting of the Rubber Association of America, in 1917, that society described, by name only, certain standard qualities of rubber. The chemical and physical properties of the four standard qualities are still left to the variable known as "good judgment." The standard samples are on file at specified places, but are available for optical inspection only. The committee in charge of these official terms felt that if it appeared desirable later on to go into the matter more comprehensively this could still be done.

The American manufacturers of rubber-goods to day fully realize that rational specifications are rapidly displacing the "good judgment" of the old type of buyer. This holds good for the man who sells crude rubber to the rubber-goods manufacturer, and it also holds good for the manufacturer who sells the finished rubber product to a railway or a municipality. I am inclined to believe that many legal cases based on breach of contract would be impossible if buyer and seller would have a care to define the chemical and physical properties which the merchandise should pos-

sess. In a like manner many disputes arising from the assessment of duties by the Collector of Customs would probably be avoided if the importers themselves had a clear knowledge of the chemical and physical properties of the merchandise which they import. Bigger than all of this is, of course, the desire on the part of the importer to abide by the letter as well as the spirit of a tariff act.

One of the immediate results of this lack of definitions in the American rubber industry was the jelutong (or pontianak) case, heard in New York City in February, 1917. An importing firm had been called upon by the Collector of Customs to pay a duty of 10 per cent ad valorem on pontianak, it having been classified as a *non-enumerated, unmanufactured article*, under paragraph 385 of the Tariff Act of October 3, 1913. The importers claimed that it was entitled to free entry as crude rubber under paragraph 513.

In presenting the evidence for the consideration of the court the importers aimed to show that jelutong is known throughout the United States, and was known, on and prior to Oct. 3, 1913, as *crude India rubber*. They further expected to show by persons who manufacture articles out of it that it is known to them as rubber, used as rubber, and has no other use than as rubber. Some of the evidence presented was interesting, to say the least, and may serve to enlighten some of our rubber manufacturers. For example, one witness for the importers stated that jelutong was not used as a filler or an adulterant in a rubber compound. The inference here is that jelutong must belong to the class of materials known as rubbers. This is, of course, a lapsus, as it is commonly known that the substances which enter into a rubber compound are classified under possibly a dozen different heads, among which are adhesives, fillers, adulterants and rubber. The fact that jelutong is neither a filler nor an adulterant is not conclusive evidence that it is a rubber. The same witness stated that he knew of no substance other than rubber which could be used in a rubber compound to hold the several ingredients together. This hardly corroborates the experience of successful factory superintendents. The witness also stated that it is generally understood (in Boston and in New York, by the trade that engages in it) that jelutong is included in the commercial designation of rubber. If this be true, it would be well for dealers in rubber to take note of this remark, as it may enable them to deliver jelutong on any contract where "rubber" is specified.

Although the importers claimed that jelutong has for some years been known as crude India rubber, it was repeatedly shown in the testimony that the phrase "rubber" is rarely, if ever, used in buying and selling. The phrases that are used are "smoky sheets," "crepe," and the like, but the phrase India rubber, or the word rubber, is seldom used. The principal witness for the importers stated that jelutong is known to everybody in the trade, discussed and known by all users as rubber. On cross-examination it was, however, brought out that the matter had never been discussed by the witness with other dealers in rubber. One witness, who described himself as a compounding chemist, stated that the use of any of the various kinds of rubber will give to a compound the same qualities that the jelutong gives to the compound; that

caoutchouc (the rubber hydrocarbon) is the prevailing ingredient of jelutong. This testimony was offered in the face of the fact that jelutong, when washed and dried, consists of approximately 25 per cent rubber hydrocarbon and 75 per cent resins.

One witness who testified to certain chemical facts in the case stated: "There are some nine hundred odd rubbers coming into the port of New York at different times." This is certainly a very generous estimate of crude rubber varieties, but rubber importers will accept this with considerable hesitation. He also testified, quite correctly, that rubber is the one material which shows both plasticity and elasticity. Fortunately for the importers, he forgot that pontianak (or jelutong) possesses little or no elasticity. It is for this latter reason that a considerable percentage of all chewing gum can be made of pontianak in whole or in part.

Owing to the pressure of bigger issues it was apparent that the Government did not secure the testimony of those who use jelutong, and so it was that some odd statements crept into the record without contradiction. Thus we find it stated that "jelutong is used in the same way and for the same purposes that other grades and qualities of rubber are used." In view of such testimony, the court had no choice but to sustain the protest and admit jelutong as "rubber." The whole case is of more than passing interest, and I have therefore taken some pains to bring to a focus our present knowledge concerning the character of the gum in dispute.

TRADE CUSTOMS, CHARACTER AND USES OF JELUTONG

In one of the trade journals we find in September, 1913, that separate statistics are presented for "gutta jelutong" and for "India rubber." This makes a careful distinction between the two gums, and this distinction was never criticised.

Of all the jelutong produced in the East Indies in 1911 and 1912, a considerable portion was passed through a manufacturing process at the Goebilt-Sarawak Works of the United Malaysian Co. The process was known as deresination, and the products obtained as a result of it are: jelutong rubber (as residue) and jelutong resin (as extract). Samples of this jelutong rubber were exhibited in New York City in 1912 at the Rubber Conference, under the name "Malaysian crepe." (See Schidrowitz: Rubber, page 110, published 1911.) In May, 1910, that chemist made an inspection of the plant at Goebilt, Borneo, and later published his observations. The United Malaysian Company in 1912 published a pamphlet in which they recommend the use of jelutong in such proportions that 100 lb. of the compound or dough contains not more than 7 lb. of jelutong.

Potts, in his book, page 34, states: "An example of a highly resinous rubber is Malay crepe. This is obtained from jelutong, a gum containing (in its wet state) only about 10 per cent rubber. This is derived from the latex of *Dyera costulata*."

Jelutong cannot be used in the same way as rubber. The best results in vulcanization are obtained when the rubber used contains not more than 8 per cent resins. Experience shows that substances containing 15 or 20 per cent resins cannot be vulcanized in the usual manner.

Jelutong is a mixture of resins and rubber, and so is the commodity known in commerce as crude rubber, but the resins in jelutong have entirely different properties than have the resins of Hevea and similar rubbers. For example, the unsaponifiable matter is approximately 15 per cent in Hevea resins and 100 per cent in jelutong resins.

The specific rotary power is $+50$ degrees for jelutong resins and zero degrees for Hevea resins.

The fact that jelutong is used in the United States principally by manufacturers of rubber products cannot affect the case, since there are numerous materials of which the same might be said (*e.g.*, vulcanized oils).

The characteristic which jelutong possesses which gives it its peculiar value is this: It renders the compound tacky or sticky, so that the compound can be used for binding together two surfaces, such as two layers of cotton duck used in building auto tires. Rubber itself does not possess this sticky character. These properties make it absolutely impossible to use jelutong in certain compounds. For example, no skilled chemist, versed in the art of rubber compounding, would use it in making auto tire treads or elastic bands or erasers. It is likewise a matter of common knowledge that no useful compounds can be prepared using jelutong and sulphur and omitting rubber. The fact that jelutong, after washing and drying, contains about 75 per cent resins and 25 per cent rubber, makes it undesirable for exclusive use as a substitute for rubber.

PROPER CLASSIFICATION OF JELUTONG

A more correct classification for jelutong would be "a resin occurring naturally admixed with rubber, in the approximate proportion of 3 parts resin and 1 part rubber hydrocarbon."

Jelutong has been used successfully in the manufacture of chewing gum in the United States. Not merely the resins, but the entire material (after washing and drying) has been used.

Rubber of commerce is a material which, when admixed with sulphur in suitable proportions, can be vulcanized into a product having distinct properties of elasticity and tensile strength. The products so obtained can be applied to useful purposes. Jelutong does not comply with these requirements.

In order to produce useful products it is not necessary to mix or blend various rubbers. If in a given recipe, no other organic material but washed and dried Hevea rubber be used, a useful vulcanized product can be produced. If in a given recipe no other organic material excepting washed and dried jelutong be used, no useful product can be produced which will in the slightest degree resemble that obtained from the Hevea rubber.

Hevea rubber, plantation crepe, and Para rubber are terms well known in the American rubber trade. In order to obtain from jelutong a product resembling these it is necessary to put it through a manufacturing process known as deresination.

Hevea rubber is a material commonly included under the term rubber. It can be converted into useful products by mixing it with, say, sulphur and zinc oxide, and subjecting the mixture to heat while under pressure. Commercial jelutong cannot be converted into useful articles in the same manner. It has, to my knowledge, never been used exclusively in the produc-

tion of commercial rubber goods. Whenever it is used in a rubber compound it is used in conjunction with some variety of rubber.

The amount of washed and dried jelutong which can be used in a rubber compound to produce useful products is limited to about 7 per cent.

It is my opinion that no manufacturer would be willing to accept jelutong, balata or guttapercha as a good delivery if he had ordered rubber.

(The first protest heard has been decided adverse to the Government, but new evidence having been gathered by the Department of Justice, a new case was prepared, and heard in December, 1917. No decision on the second case has been handed down at this time.)

The Rubber Trade Laboratory,
Newark, New Jersey.

Saving Ammonia Urged.—The Food Administration to-night issued an appeal to the owners and operators of ice-making and refrigerating plants to take every possible precaution against waste and leakage in their use of ammonia.

As a means of effecting ammonia savings owners and operators of plants were urged to institute a bonus system by which employees would be rewarded for effecting economies. Each plant will be required to report on the first of each month exactly what it is doing in saving ammonia.

"During 1918," the announcement said, "the Government should have for munitions alone 20,000,000 lb. of ammonia more than it is possible to make by working all plants in this country to capacity."

"This shortage will be greatly increased by the ammonia that will be furnished ice-making and refrigerating plants, but it is hoped that by appealing to the patriotism and the sense of all ammonia users and urging them to stop all waste and leakage, the usual consumption may be curtailed to such an extent as will permit at least the most efficient plants to run, particularly where natural ice is not available."

Releasing Shipping by Developing Our Mineral Deposits.—Secretary Lane has asked Congress for a special appropriation so that a large force of metallurgists can be set to work on the necessary changes in practice to use lower grade manganese ores, and that geologists and engineers can be employed to develop deposits of materials in this country which are now imported. In this manner Secretary Lane believes considerable ship tonnage can be released to carry food and supplies to France. The minerals most needed are nitrate, pyrites, sulphur, manganese, graphite, tin, mercury, potash, tungsten, antimony, chrome, magnesite and mica.

Payment of United States Patent Office Fees on Enemy-Owned Patents.—The War Trade Board has authorized the payment of United States Patent Office fees requisite for the filing, prosecution, registration and preservation of patents, trade-marks, prints, labels, or copyrights, of an "enemy" or "ally of enemy" by any person within the United States, where such person is the holder of a power of attorney granted by such "enemy" or "ally of enemy"; provided, however, that when such fees are to be paid from the funds of an "enemy" or "ally of enemy" in the United States, such payment shall be made subject to the approval of the Alien Property Custodian.

Recovering Ammonia at Tar-Distilling Plants

By CLARENCE R. WOODWARD

ALTHOUGH it has long been known to tar distillers that a certain amount of ammonia is present in the water contained in ordinary coke-oven, gas-house or vertical-retort tars, the large manufacturers of this country have not up to recently considered that its recovery, if it could be effected, would be profitable to them. This opinion has probably been due to the fact that very little has been done in the way of experimenting to find the actual state in which the ammonia is present, its strength or the possibilities of recovery.

In the past two years the writer spent considerable time working on this subject at one of the plants of probably the largest of the tar distillers in the United States. The results obtained show that not only can ammonia be easily recovered, but that due to many favoring circumstances connected with the character of the equipment of a distilling plant, its recovery at these particular plants can be accomplished very profitably.

SOURCES OF AMMONIA

At the tar works there are two sources from which ammonia can be recovered; the liquor which settles out on the top of the crude-tar storage tanks and the liquor which comes over with the light oil in the process of distilling the tar. As the storage tanks are both filled and emptied from the bottom, this liquor settling on top of the tanks is commonly allowed to accumulate undisturbed until such time as the amount begins to take valuable storage space, when it is run to waste. The distilled liquor will be shown to be by far the most profitable source, due to its great volume and strength; but, as is the case with the settled liquor, it has usually been allowed to run to waste. It will be the purpose of this article to show how these liquors can be converted into a profit for the tar distiller.

At the particular plant at which the experiments to be described were made, the coal tar received in the course of a year consisted of about 9,000,000 gal. coke-oven tar; 4,000,000 gal. gas-house tar and 600,000 gal. vertical-retort tar. About two-thirds of this tar was distilled at the plant, the remainder being disposed of in a crude state for road-building purposes, under trade names tending to disguise its true composition.

LABORATORY TESTS

Before any large-scale operations were attempted, laboratory tests for ammonia were made on the water settling on the top of the storage tanks and on the water distilled from the different kinds of tars in the laboratory. The results given are expressed in ounces of ammonia per gallon of liquor and also in the percentage of anhydrous ammonia, the percentage being obtained by dividing the number of ounces per gallon of liquor by 3.88.

Tests of the liquor settling out from the tar in storage are given in Table I.

TABLE I—LIQUORS SETTLING ON TARS

Tank No. and Class of Tar	Volatile Ammonia, Oz.	Fixed Ammonia, Oz.	Total Ammonia, Oz.	Per Cent Ammonia
No. 2 coke-oven.....	1.41	4.39	5.80	1.50
No. 3 gas-house.....	.705	1.77	2.48	.64
No. 11 gas-house.....	.82	1.58	2.40	.62
No. 12 gas-house.....	.69	2.22	2.91	.73
No. 22 vertical-retort.....	No water settled out.			

An examination of the liquor distilled in the laboratory from each of the three different classes of tar, coke-oven, vertical-retort and gas-house, showed an average strength as follows:

TABLE II—LIQUORS DISTILLED FROM TARS

Class of Tar	Strength Ammonia from Laboratory Sample, Oz.	Total Ammonia, Per Cent
Coke-oven.....	9.76	2.52
Coke-oven plus NaOH.....	12.1	3.12
Gas-house.....	2.84	.73
Vertical-retort.....	8.5	2.19

In the distillation of these tars the condenser was kept at all times absolutely cold, so that never was there any danger of ammonia loss. Under these conditions the strength of the liquor obtained represents the maximum that can be recovered from these tars in practice. The second test with NaOH was made for the purpose of seeing if the fixed ammonia in the tar could be broken up in the process of distilling.

The results of the experiments on the settled liquor indicated that with the exception of that on the coke-oven tar the strength in ammonia was very low. In fact, were it not possible to mix them with stronger liquors, recovery of the ammonia contained in them would not be practicable regardless of the volume available. It should be noted that about 70 per cent of the ammonia in this liquor is fixed and would necessitate using lime in the process of concentrating.

The water distilled from the tar, however, is found to be considerably stronger in ammonia than the water separated from the tar on standing, and suggests very profitable recovery.

The great difference in the strength of these two classes of liquor is noticeable, particularly in the tests of the water from the coke-oven tar, which contains 5.80 oz. ammonia in the settled liquor and 9.76 oz. in the distilled liquor. This is probably due to evaporation of ammonia from the surface of the water in the storage tanks, an action which takes place to a greater or less extent, according to the heat of the tar and to the surface exposed to the air, and which causes a smaller amount of NH_3 in the settled liquor. The fact that the tar itself contains some ammonium compounds aside from those in the water with which it is intimately mixed causes a corresponding increase in the amount of ammonia in the distilled liquor.

It is rather remarkable, however, that the water distilled from the coke-oven tar should contain 9.76 oz. of free ammonia while the water separating from the same tar on standing contains only 1.41 free ammonia.

The explanation is that the distilled liquor contains only free ammonia for the reason that when the tar is distilled the free ammonia passes over with the water and the fixed ammonia remains behind. In the settled liquor the free ammonia has evaporated from the causes mentioned above.

The result of the test with caustic soda indicates that an additional amount of ammonia may be recovered through the breaking up of the fixed ammonia remaining in the tar. It was not, however, considered worth while to try out this test on a large scale in view of the difficulties likely to be encountered through the action of the caustic on the tar.

LARGE-SCALE TESTS

Ammonia tests were now made on water obtained from the distillation of tar on a large scale, 10,000-gal. direct-fired stills being used. In the making of road-building material and pitch it is customary at this plant to mix coke-oven tar and gas-house tar in about equal proportions. Most of the tests, therefore, were made on the water distilled from such mixtures. However, to make the experiment more complete, a special still of straight coke-oven tar and a still of vertical-retort tar were run to fuel pitch for the purpose of obtaining the liquor from these particular tars. The water was caught in the usual 100-gal. drums, from each of which a sample was taken to be tested for its ammonia content. During the time the water was coming from the still the condensers were kept a little cooler than is usual when no attempt is made to recover ammonia. The average of several tests on the tar mixtures is given in Table III.

TABLE III—AMMONIA LIQUOR FROM MIXTURE OF COKE-OVEN AND GAS-HOUSE TARS

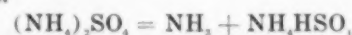
Tub No.	Total Ammonia, Oz.	Total Ammonia, Per Cent
1.....	11.50	2.96
2.....	5.80	1.49
3.....	3.90	1.01
4.....	1.90	.49
5.....	1.60	.41
6.....	1.17	.30
7.....	2.90	.75
	28.77	Av. 1.058
	Av. 4.11	
(Average of first 3 tubs, 7.07 oz., or 1.82 per cent.)		
LIQUOR FROM COKE OVEN TAR		
	9.52	2.45
LIQUOR FROM VERTICAL RETORT TAR		
	8.25	2.13

The strength of the liquor from these last two tars is found on comparison to differ slightly in strength from the tests of 9.76 oz. and 8.5 oz. obtained from the same tars in the laboratory. However, I believe the difference is no greater than should be expected in view of the necessarily great variation in the two methods of distilling and sampling.

The ammonia in all of these distilled liquors was found on testing to be approximately 99 per cent free and 1 per cent fixed. The small amount of fixed ammonia in the liquor is probably due to combinations made with the gases in the condenser, or with salt water which may have leaked through the condenser coils. The condensers are cooled with salt water.

It is interesting to note that in the results of the tests of liquor from the distillation of the mixed tar, the last pan, or tub, is stronger in ammonia than the three preceding it. This fact was rather puzzling at first, but I finally judged it to be due to the formation

of NH_3 from the fixed ammonia $(\text{NH}_4)_2(\text{SO}_4)$ at high temperature.



According to Bloxom this breaking down begins to occur about 100 deg. C. and is complete about 300 deg. C. The temperature of the tar is usually about 160 deg. C. in the still as the last of the water is being removed.

LIQUOR RECOVERED IN PRACTICE

In order to ascertain if this ammonia liquor could actually be recovered without loss in practice, an 18-day test was run, during which time the liquor from all the stills instead of being allowed to run to waste was dumped into ground tanks and from there pumped into a storage tank holding about 5700 gal. When full, this tank was emptied, several samples being taken of the liquor as it ran from the bottom. In this test the liquor obtained was subject to some contamination from rain-water and from salt water dripping from the condensers, but the amount was not sufficient to affect the results materially. The tests given in Table IV are the average of the several samples taken from each tank.

TABLE IV—ANALYSIS OF CONSERVED LIQUOR

Tank No.	Gross Gallons Water	Ounces Ammonia Per Gallon
	4,982 { Not included 5,734 { in total	4.63 4.01
1.....	5,734	3.84
2.....	4,892	4.88
3.....	5,734	3.94
4.....	5,358	4.07
5.....	5,734	4.46
6.....	5,640	2.77
7.....	5,295	3.95
8.....	3,290	5.12
	41,767	Average 4.17
	Tar 2,051	
39,716 net gal. water for 18 days		

This water was all taken from mixtures of gas-house and coke-oven tars, and from the figures obtained it is evident that if care is used to prevent evaporation there is very little loss to be anticipated in recovering the ammonia. The average test of 4.17 oz. agrees very closely with the average strength of 4.11 oz. in the liquor as it is given off from the still and before it is dumped into the ground tanks.

The composition of the distilled liquor, containing as it does 99 per cent of its ammonia in a free state, constitutes a most favorable condition for concentrating for the reason that no lime will be required. Not only is considerable expense thus saved, but a troublesome step in concentrating is eliminated.

From the experiments made, it appears that the bulk of the liquor recovered at the stills when the usual tar products are being made will average 4.11 oz. strength, a liquor considered workable, especially in view of the fact that ammonia is in a free state and to the circumstance of cheap steam and water being always available at the works. Should it be found desirable, however, to obtain a stronger liquor at the expense of the total ammonia recovered, it is only necessary to eliminate the last few tubs of weak liquor. A strong ammonia liquor will always be obtained when straight coke-oven and vertical-retort tars are distilled.

ESTIMATE OF PROFIT

Records of the plant show that the total amount of water distilled from the tar in the course of the year

averages about 700,000 gal. The water settling out of the coke-oven tar in the course of a year is 76,000 gal. and that on the gas-house tars 256,000 gal.

Assuming all the ammonia concentrated to a liquor of 20 per cent strength, which has at this time a value of about \$0.10 a pound at the works, the total amount and value would be at this plant:

Liquor settling on coke-oven tar:

$$76,000 \times 8.35 \times 15\% = 9,520 \text{ pounds ammonia}$$

Liquor settling on gas-house tar:

$$256,000 \times 8.35 \times .665\% = 14,220 \text{ pounds ammonia}$$

Distilled from tar:

$$700,000 \times 8.35 \times 1.058\% = 61,840 \text{ pounds ammonia}$$

Total 85,580 pounds ammonia

Total value of ammonia, $\$0.10 \times 85,580 = \$8,558$.

If any considerable amount of coke-oven tar or vertical-retort tar is distilled without admixture of gas-house tar, as is the case when ordinary fuel or briquet pitch is made, the amount of ammonia recovered will be greatly increased.

The only apparatus required in addition to that present in all distilling plants is an ammonia concentrator for concentrating the weak liquor, a few small tanks and a little additional piping. The same pumps and pump lines used for oil can be used for handling liquor, cheap steam is, of course, available and the labor, which is usually a small item in concentrating particularly when no liming apparatus is used, can be accomplished by the regular stillmen and the hiring of extra help avoided.

The cost of the concentrator, together with the tanks and including the labor of setting up, would be about \$4,000. The operating cost of concentrating the liquor per pound of ammonia recovered is estimated in Table V:

TABLE V.—COST PER POUND AMMONIA

Steam	\$0.0066
Labor and supervision	0.0030
Lime	0.0005
Repairs, paints, etc.	0.0010
Interest and depreciation	0.0059
Contingencies	0.0030
	<hr/> \$0.0200

The total value of the ammonia being approximately \$8,558, and the cost of recovering \$1,712, a profit of approximately \$6,746 a year is indicated at this plant.

It is not necessarily true that the above results would be duplicated at every plant distilling similar amounts of tar, for, as is well known, the quantity of ammonia present in a tar will vary with different methods of recovering tar at gas works and with kind of coal used in these plants. It is believed, however, that the results will not be materially different from those cited except in plants where the tar is bought already dehydrated.

In the particular plant where these experiments were made the coke-oven tar secured by the distillers is made from New River coal and the vertical-retort tar from Westmoreland coal. The gas-house tar represents the average of 30 or more different tars obtained from perhaps as many different coals. The company appropriated \$4,000 to this plant to cover the cost of installing the ammonia concentrator and the other necessary apparatus and if it proves successful they expect to install a concentrator at their other plants. At the present time it should make a very profitable investment.

Melrose, Mass.

A Gas Dilatometer for Ascertaining Decomposition Points

Determination of the Decomposition Points of Cane Sugar, Dextrose and "Soluble Starch"

BY WILLIAM C. MOORE AND J. B. DAVIES

DURING a recent investigation in this laboratory it became necessary to determine the decomposition points of a number of organic materials. As the apparatus devised for this purpose has served us so well, it was thought that a description of it would be of interest.

In its essentials, the arrangement we made use of consists simply of a glass decomposition bulb which is immersed in a suitable heating bath; an outlet tube containing a horizontal expanded portion which serves as a combined air condenser and receiver for volatile substances distilled out of the material being studied, and a mercury manometer with a scale attached to measure the pressure developed.

The construction details are easily seen in Figure 1.

The heating chamber *A* is conveniently made from an 8-in. test-tube, to the upper end of which is sealed the riser *B*. The horizontal bulb *D* which serves as an air condenser can likewise be made from an 8-inch test-tube. The mercury-filled manometer is shown at *E*. The shorter tube of this manometer is about 810 mm. long; the longer, with the open end, about twice this length. A thermometer is used for measuring the temperature of the condenser *D*.

In making a run, an appropriate quantity of the substance to be decomposed is weighed into a small glass tube *G*. This tube is placed in an 8-inch test-tube, the latter drawn down to a neck and sealed onto a short piece of glass tubing which serves as the riser *B*. This is then sealed to the rest of the previously assembled apparatus just below the *T*. The outfit is now ready to be placed in position with the bulb *A* completely immersed in the heating bath. Sufficient clean, dry mercury is introduced into the manometer to form a column in the shorter tube, at least 760 mm. longer than that in the open tube after exhausting. In introducing the mercury, air bubbles can be dislodged by a piece of iron wire moved up and down in the open tube. This

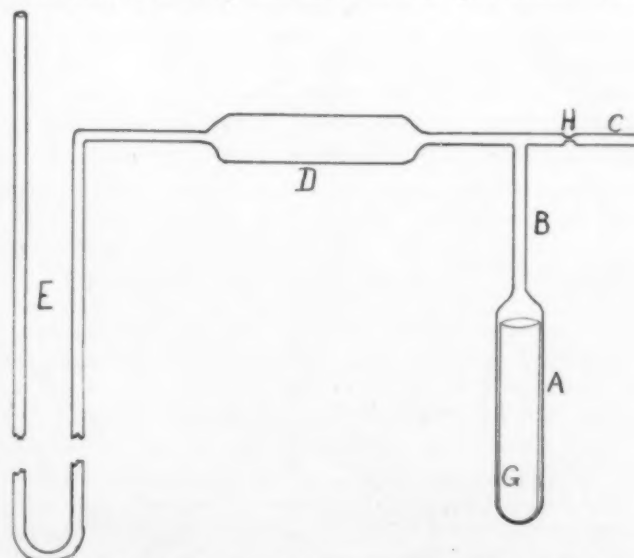


FIG. 1. APPARATUS FOR DECOMPOSITION POINTS

wire must be long enough to reach the bend of the manometer.

The apparatus is now exhausted to a barometric vacuum through the outlet *C* and sealed at the constriction *H*. When all is ready the bulb is heated at a definite rate, readings being taken at regular intervals of the temperature of the heating bath, the temperature of the condenser, the difference in level between the mercury columns and of the barometric pressure. The total pressure within the apparatus is easily obtained by subtracting the difference in manometer levels from the barometer if the pressure is less than atmospheric,

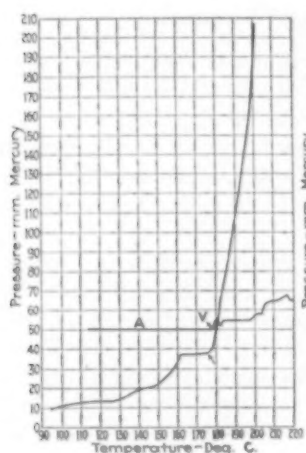


FIG. 2

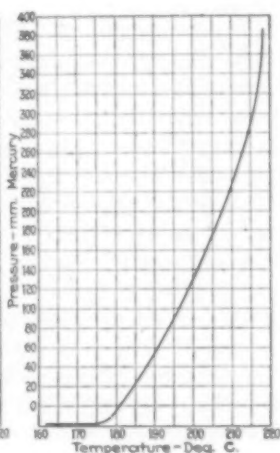


FIG. 3

or by adding these two quantities when the pressure is greater than the barometer reading. These pressures are plotted against the corresponding temperatures. In those cases where decomposition occurs, due to a permanent gas being formed by an irreversible reaction, the curve will show a sharp upward bend very similar to those shown in decomposition voltage curves.

If the condenser tube is not shielded from the heating bath, the temperature within it may rise to a high value. Where water is given off, the vapor pressure of the water within this part of the apparatus can readily be found from tables of vapor pressure of this liquid at different temperatures. This value may be subtracted from the total pressure to get the actual pressure of the permanent gas. However, proper shielding keeps the condenser tube at a fairly constant temperature which is approximately that of the room, in which event the vapor pressure of the water need not be taken into account since we are interested only in the singular points on the curve and not in the actual magnitude of

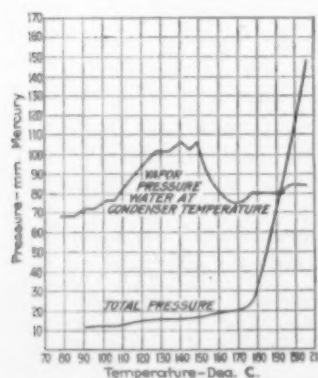


FIG. 4

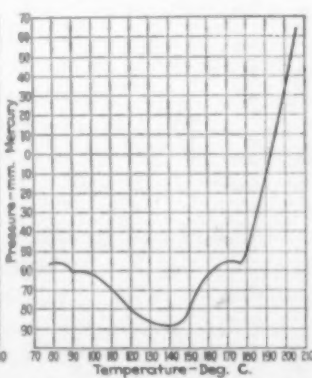


FIG. 5

the pressures developed. In some cases the rapid evolution of gas from the decomposing material will heat the condenser bulb also; this is shown on curve A* of Fig. 2 (Point V).

Working in the manner just outlined, the decomposition points of cane-sugar, dextrose and soluble starch were ascertained. In this case, the rate of heating was at about 1 deg. C. per minute up to 150 deg.; a little slower above that point. The heating bath was a large pail of paraffin which was continuously stirred by a paddle actuated by a motor.

Table 1 gives the summarized results. Figures 2 and 4 are the pressure curves obtained on two runs with cane-sugar. Figures 3 and 5 respectively are the corresponding curves after correction had been made for the water vapor in the apparatus. In Figure 5 it is possible that the contents of the condenser were not at as high a temperature as the outside thermometer showed.

TABLE I

DECOMPOSITION POINTS

Material Used	Decomposition Point
Cane Sugar	178 deg. C.; 177 deg. C.
Dextrose	177 deg. C.
Soluble Starch	214 deg. C.

Mercury in glass thermometer used.

The rate of heating is very important. Thus, at the slow rate of heating of 5 deg. per hour, cane-sugar decomposed at 155 deg. C., while soluble starch broke up at 185 deg. In these latter cases a Hoskins furnace up-ended was used as a large air bath.

This lowering of decomposition point by a decrease in the heating rate may be explained in this way; at a slow rate of heating, the sugar or starch molecules undergo some internal change which results in a less stable compound than the original sugar or starch being formed; while at a rapid rate, sufficient time does not elapse for such a change to occur.

Another possibility is that with very rapid heating (as at the rate of 1 deg. per minute) the material becomes superheated before decomposition occurs. With a number of other materials a similar elevation of the decomposition point was noted when the rate was changed from 5 deg. to 10 deg. per hour; this would indicate that with the 1-deg.-per-minute rate, the phenomenon is not due to delay in the decomposition material reaching the temperature indicated by the thermometer.

In order to correlate these results, work on other carbohydrates is planned.

A preliminary experiment, just completed, shows that a good quality of quantitative filter paper, when heated at 10 deg. per hour, did not exhibit a very sharp decomposition point; the evolution of gas began slowly at 143 deg.¹ There was some indication of a break at 185 deg. and a little sharper break at 204 deg. This material will be further investigated.

Research Laboratory,
National Carbon Co., Inc.,
Cleveland, Ohio.

*Curve A shows the vapor pressure of water at the condenser temperature.

¹Hollings & Cobb (*J. Gas Lighting and Water Supply*, 132, 24, 1915; *J. Chem. Soc.*, July, 1915) have made a thermal study of the carbonization process. Altho they state that they attach no importance to the indications of their differential thermo-couple below 200° C., yet the curve they show for cellulose indicates that there is a gradual but considerable decomposition of this material, extending from a little under 150° C. up to 200° C.

The Physical Properties of Copper and the Factors by Which They Are Affected—III.

BY PAUL D. MERICA

Division of Metallurgy, U. S. Bureau of Standards

(Continued from page 195)

Physical Properties at Higher and Lower Temperatures

1. ELECTRICAL CONDUCTIVITY

NORTHROP (54) has determined the electrical resistivity of a sample of high conductivity copper from 20 deg. to 1450 deg. His curve is reproduced in Fig. 17.

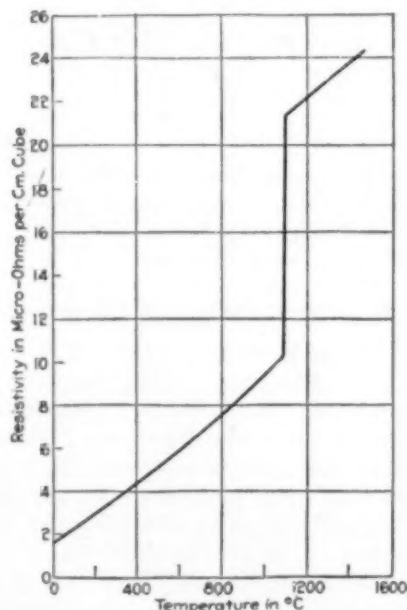


FIG. 17. THE ELECTRICAL RESISTIVITY OF COPPER AT HIGHER TEMPERATURES (54)

Dewar and Fleming (161) have determined in terms of platinum resistance temperatures the resistance of copper at low temperatures, using an electrolytic copper, drawn into wire without melting or heating, but subsequently annealed in hydrogen. Their results are as follows:

Temperature, Deg. C., Calculated By Dickson (162)	Temperature on the Platinum Resistance Scale	Resistance of Copper, Ohms (Meter, mm ²)
201.7	.....	0.029269
0.55	.....	0.015639
-39.4	.....	0.012975
-81.9	-78	0.010243
-197.1	.....	0.002887
-206	-223.2	0.001436

2. MECHANICAL PROPERTIES

The mechanical properties which have been investigated at higher temperatures are chiefly those determined in the ordinary tensile test. Such determinations are complicated by several factors; the results are dependent upon the rate of loading and on the atmosphere in which the tests are carried out. It is not, therefore, surprising to find considerable variation in the results of different observers. An idea of the range of results may be obtained from Fig. 18, in

which ultimate tensile strengths and elongation in 2 in. are plotted as a function of temperature at which the tests were made.

Bengough and Hanson (152) come to the following conclusions:

(1) "The nature of the atmosphere has an important influence on the results of tensile tests at high temperatures. An oxidizing atmosphere gives high ductility (at least with B.S. copper) at high temperatures.

(2) The existence of a range of low ductility in the neighborhood of from 250 deg. C. to 450 deg. C. is confirmed.

(3) Oxygen and arsenic lower the ultimate strength and increase the ductility at high temperatures." This last deduction is perhaps not in accordance with the well-known fact that arsenical copper softens upon an-

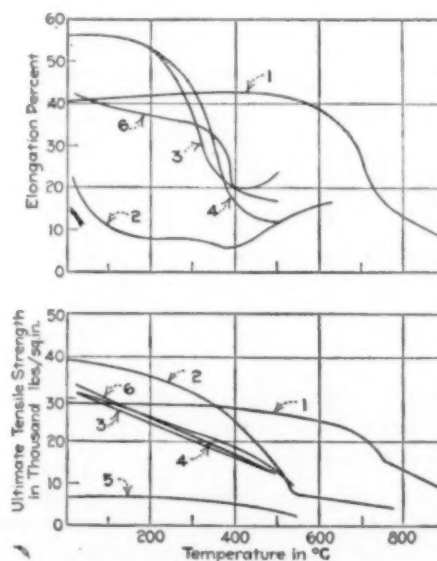


FIG. 18. EFFECT OF HIGH TEMPERATURES ON MECHANICAL PROPERTIES OF COPPER

Curves 1 and 2 (152) are for annealed electrolytic copper (oxygen, 0.08%; arsenic, 0.003%; iron, trace), and rolled arsenical copper (oxygen, 0.13%; arsenic, 0.13%; iron, 0.02%; lead, 0.10%; tin, 0.08%) respectively. The former was tested in air, the latter in CO₂; in both tests a constant rate (1.120 lbs./sq. in. per minute) of loading was used.

Curves 3 and 4 (156, 157) are for annealed electrolytic copper (arsenic, antimony, selenium, tellurium less than 0.05%; bismuth, 0.0005%) and for arsenical copper (arsenic, 1.2%) respectively, tested in air. Curve 5 gives the yield point for the electrolytic copper. Rate of loading was not constant nor given.

Curve 6 is for "pure" copper. (159).

nealing at higher temperature than pure copper. However, the yield point, not the ultimate strength, determines the latter characteristic.

Huntington (156, 157) has carried out alternating stress tests on copper up to 500 deg. C. and finds that the number of alternations to failure decrease with the temperature of test in much the same manner as does the ultimate strength.

Guillet and Bernard (153) have carried out impact tests on copper up to 1000 deg., and find a linear decrease of the specific impact work required to bend the specimens (none of the test specimens fractured).

Heat Treatment of Copper; Effect on Physical Properties

Cold-worked copper is softened by annealing, the ultimate tensile strength being decreased and the ductility increased. The temperature range within which this softening takes place most rapidly is from 200 deg.

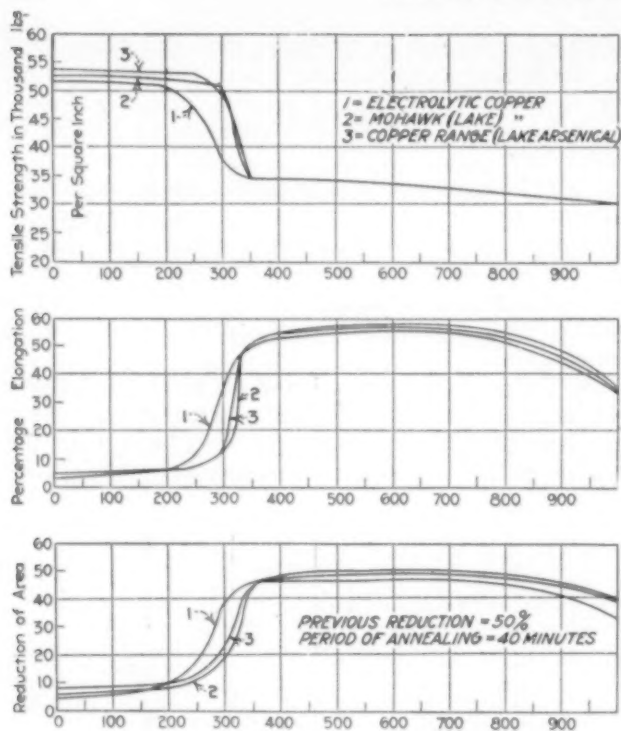


FIG. 19. EFFECT OF ANNEALING ON MECHANICAL PROPERTIES (TENSILE TEST) OF COMMERCIAL VARIETIES OF COPPER (191)

	% Oxygen	% Arsenic + Antimony	% Silver
Curve 1. Electrolytic copper .....	.071	.000	.0005
Curve 2. Mohawk copper (Lake) ..	.052	.096	.069
Curve 3. Copper Range copper (Lake arsenical) .....	.055	.296	.052

Previous reduction, 50%.

to 325 deg. C. for pure copper, reduced 66⅔ per cent (186, 197), but is markedly affected by two factors:

- (1) Extent of previous cold reduction,
- (2) Presence of impurities.

Fig. 19 shows the annealing characteristics of three

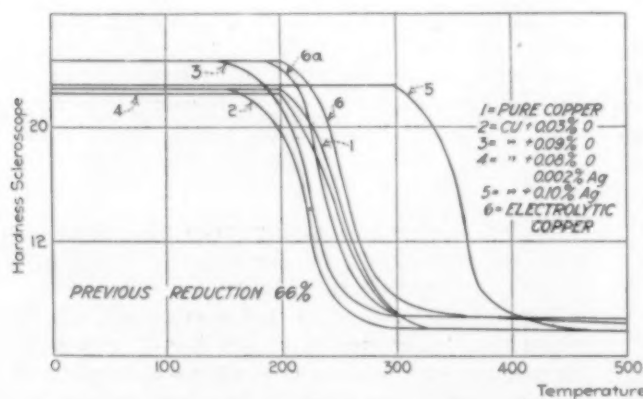


FIG. 20. EFFECT OF IMPURITIES ON THE ANNEALING PROPERTIES OF COPPER (186)

commercial grades of copper, the same, of which the characteristics were described on page 193 and in Fig. 16, and of which the analyses were then given. It is noticed that the presence of arsenic raises the annealing range of the copper.

Impurities such as arsenic and silver raise the annealing temperature range of hard copper; oxygen lowers it. This is seen from the curves in Fig. 20.

The range of softening temperatures for copper is lower the greater the previous cold reduction. This is shown in the curves of Fig. 21.

Bardwell has studied the effect of annealing in raising the conductivity of hard drawn copper wire. His curves are given in Fig. 22.

The properties of copper are not affected by a rapid cooling after annealing or rolling as are steel and certain copper alloys. It is generally held that quenching copper in water after annealing produces a softer metal than if it were slowly cooled; there is, however, evidence both for and against this view.

Martens (140) found that two similar bars of copper, cold-worked and annealed, of which one (a) was quenched and (b) was slowly cooled, possessed the following properties:

	TENSILE STRENGTH		Elongation in 10 cm., per cent	Reduction of Area, per cent
	Lb./Sq. In.	Kg./mm. ²		
(a)	30,900	21.7	47.1	57
(b)	30,800	21.6	51.8	60

Johnson (261) also finds that his specimen EE, Table IX, which was cooled slowly after hot rolling has a greater ductility than two specimens of similar composition which were quenched.

Impurities in Copper; Effect on Physical Properties

The various physical and other characteristics of copper are affected in quite varying degree by the presence of impurities. Most markedly sensitive are the electrical and probably also the thermal conductivities and the mechanical properties (particularly ductility), especially at high temperatures, to the presence of impurities. The melting (also boiling) point is changed by the presence of impurities; information concerning this is given by the equilibrium diagrams of these elements and copper. It has been noted that the mag-

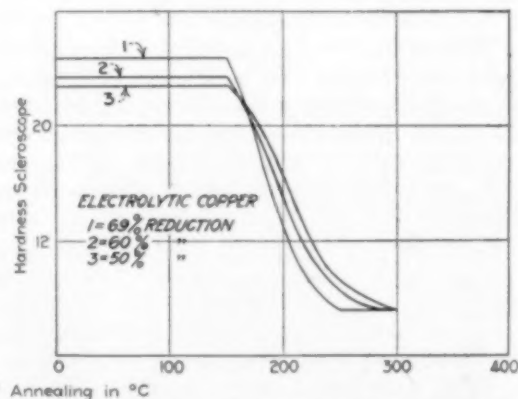


FIG. 21. EFFECT OF EXTENT OF PREVIOUS REDUCTION ON TEMPERATURE ANNEALING RANGE FOR COPPER (186)

netic susceptibility is very profoundly altered by the presence of slight amounts of iron. Otherwise the effect of impurities in the amounts ordinarily found in good commercial grades of copper have but little influence on it. The specific heat, for example, is an additive constant. Practically no data are now available concerning the effect of small amounts of impurities on the characteristics of copper other than those mentioned

1. ELECTRICAL CONDUCTIVITY

Addicks (243) has investigated systematically the influence of impurities on the electrical conductivity of copper. He used high conductivity wire (99.5 to 101 per cent) in making up his alloy ingots; this was melted in a reducing atmosphere under charcoal with the added impurity. The ingot was cast in a heated iron mold, swaged down and drawn cold to No. 12 B. & S. gage. The wires were then all annealed by passing 110 amperes through them and tested. Fig. 23 gives a summary of the results of his tests. The presence of all of these impurities lowers the conductivity, arsenic, phosphorus and aluminium being particularly effective in this direction.

2. MECHANICAL AND "WORKING" PROPERTIES

A great deal of investigation has been made of the effect of individual impurities on the mechanical prop-

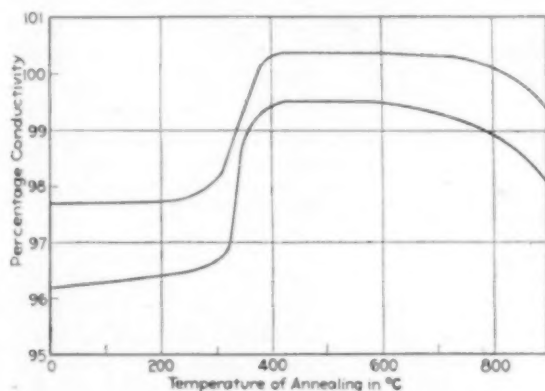


FIG. 22. EFFECT OF ANNEALING UPON THE ELECTRICAL CONDUCTIVITY OF HARD DRAWN COPPER (185)

	% Oxygen	% Arsenic + Antimony	% Copper + Silver
Material 1..	0.070	0.0038	99.92
Material 2..	0.046	0.0038	99.945
Previous reduction not given.			

erties of copper, not all of which has been conducted with a full recognition of the factors which must be considered in manufacturing conditions. A knowledge of the effect of an impurity in small amounts on the otherwise pure copper is undoubtedly valuable, but such copper is not a commercial product. From the practical viewpoint the effect of such impurities should always be considered in conjunction with that of the other usual impurities, principally oxygen. It is a fact that the effect, particularly of lead, antimony and bismuth, is most markedly altered by a variation of the presence of oxygen, arsenic, and other elements.

In considering the effect of individual elements a knowledge of the equilibrium diagrams of the binary alloys of these elements with copper is really necessary. Reference is made to these in the bibliography. The impurities to be considered may be classified according to whether moderate amounts of it are soluble as a solid solution in copper (manganese, nickel, zinc, tin, aluminium, etc.) or whether the impurity is but slightly soluble in the copper (bismuth, lead, etc.). It is then found in general that impurities of the former class harden copper, diminish its ductility, but increase its toughness and better its rolling and working properties, whereas those of the latter class do not harden the copper, but diminish both the ductility and the toughness and are quite injurious as regards the hot-work-

ing properties. The reason for this latter effect is to be found in the presence of the impurity as segregated particles or films of low melting point (300 to 500 deg. C.). The action of arsenic and oxygen is more complex.

ALUMINIUM

The equilibrium of copper-aluminium alloys has been studied by Carpenter and Edwards (196), Curry (197), and Gwyer (198). Copper takes up approximately 9 per cent of aluminium in solid solution.

Some results of Johnson (261), Table IX, indicate the effect of this metal on the properties of copper.

ANTIMONY

The constitution of the copper-antimony alloys has been studied by Hiorns (200) and Baikoff (199). From 2 to 3 per cent of antimony as Cu_3Sb are held in solid solution by copper.

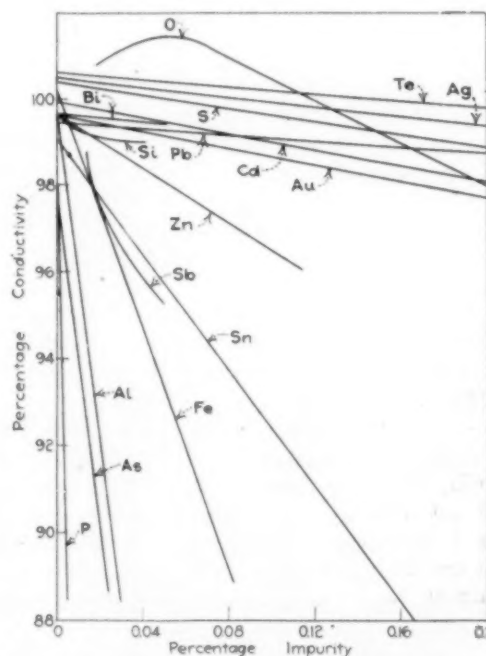


FIG. 23. EFFECT OF IMPURITIES ON THE ELECTRICAL CONDUCTIVITY OF COPPER (ADDICKS) (243)

Johnson (259) has studied the effect of antimony versus the mechanical and working properties of "tough-pitch" copper. He drew the following conclusions from his results, which are summarized in Table V:

"(1) Antimony up to 0.5 per cent has no detrimental influence on the hot-forging qualities of 'tough-pitch' copper free from other impurities. It is even possible to forge copper containing 1 per cent antimony if sufficient oxygen be present.

"(2) In copper which has been overpoled, antimony tends to mitigate the phenomenon of 'spewing' during solidification.

"(3) 'Tough-pitch' arsenical copper (0.4 per cent arsenic) is slightly hardened after hot-rolling by the presence of antimony (0.2 per cent), but otherwise its mechanical properties are slightly improved.

"(4) The mechanical properties of 'tough-pitch' pure copper after rolling and annealing are but slightly altered by small additions of antimony. The tensile strength is slightly raised (5 per cent), and the elongation lowered (10 per cent). The slight gain in toughness is probably traceable to the greater soundness of the ingot.

"(5) With regard to the structural condition of antimony in 'tough-pitch' copper, it exists in two forms:

- "(a) Partly in solid solution (as Cu₃Sb).
 "(b) Partly as an insoluble compound with oxygen (slate-colored 'oxidules').
 "Oxygen in excess exists as Cu₂O. The latter, together with the antimony oxidules, form a ternary eutectic with the solid solution."

TABLE V—INFLUENCE OF ANTIMONY ON "TOUGH-PITCH" COPPER, JOHNSON (259)

Specimens taken from rolls rolled at red heat (900° C.) from 1½-in. square ingots; red rolled in 6 passes to ½ in., finished at dull red heat, annealed by raising to a bright red heat, quenched in pickling bath, rolled cold to ⅜ in., and straightened by drawing once through a die. All ingots were to tough-pitch, with level surface; they all rolled perfectly. The copper used was the purest electrolytic (Vivian & Sons, Swansea).

No. of Ingot	CHEMICAL COMPOSITION			RODS AS ROLLED			RODS AS ANNEALED		
	Oxygen, per Cent	Arsenic, per Cent	Antimony, per Cent	Tensile Strength, Lb./Sq. In.	Elongation in 3 In., per Cent	No. Alternations to Rupture, Arnold Test	Tensile Strength, Lb./Sq. In.	Elongation in 3 In., per Cent	No. Alternations to Rupture, Arnold Test
RR	0.05	...	...	44,400	14.7	118	32,200	51.3	244
A5	0.058	...	0.2	43,700	13.0	136	31,900	43.3	210
A2	0.054	...	0.29	43,600	16.7	116	33,500	46.0	268
AA2	0.063	...	0.3	43,800	13.0	118	32,800	48.3	258
AA1	0.33	...	0.49	45,500	6.0	49	34,000	44.7	138
A	0.065	0.36	0.2	45,200	15.3	119	33,500	48.7	258

All of the ingots given in the table rolled well, hot; ingot A1, containing antimony, 0.5 and O₂ 0.02 (over-poled), was red-short and was removed from the rolls at the third pass; samples of ⅝-in. rods were rolled cold after annealing into strips ⅛ in. thick. Rods RR, A, A2 and AA2 showed no edge cracking; AA1 showed edge cracking when a thickness of 3/16 in. had been reached.

There is much further information of a special nature in this paper and the discussion on it which will interest those desiring more complete information on this subject.

The earlier investigators of this subject were Hampe (253), Hiorns (256), Greaves (252), T. Johnson (264), Lewis (269), Archbutt (244). Hampe finds that copper with 0.53 per cent antimony can be drawn into wire, and with 1 per cent antimony is red-short. Hiorns finds that antimony (0.2 per cent) when added to copper containing lead (0.2 per cent) diminishes the brittleness caused by the lead.

Bauke (246) has determined the effect of antimony on the toughness (specific impact work necessary for fracture) of copper; see Table X.

ARSENIC

The constitution of the copper-arsenic alloys has been studied by Friedrichs (201) and by Bengough and Hill (202).

A compound Cu₃As is formed which is partly soluble in solid copper; the exact limit of solubility has not been determined; it lies probably between 1 and 3 per cent arsenic (i.e., copper will take up in solid homogeneous solution that quantity of arsenic as Cu₃As).

Next to oxygen this is probably the most important impurity occurring in copper. Lewis (268) and Bengough and Hill (247) have studied its effect on the mechanical properties of rolled copper; their results are summarized in Tables VI and VII.

Bengough and Hill summarize their mechanical tests as follows:

- "(1) Arsenic in small quantities tends to increase the maximum stress without affecting appreciably the ductility of these alloys.
 "(2) It increases their resistance to reducing gases at high temperatures.
 "(3) Alloys with low percentages of arsenic tend to

be unhomogeneous, but with increase in the arsenic this ceases to be apparent.

"(4) In ordinary oxidizing atmospheres no heat treatment (for three hours or less) short of an approximation to fusion seriously affects the properties of these alloys. The only result of annealing is to render the bars slightly more homogeneous and to lower the yield-point somewhat. This statement, however, does not apply to annealing temperatures in the neighborhood of 1000° C.

"(5) Alloys containing less than 1 per cent of arsenic are ruined by the action of reducing gases for three hours at 700° C. or above it; in some cases the action is apparent at 600° C.

"(6) The yield-points of these alloys are somewhat variable and unsatisfactory.

TABLE VI

Influence of arsenic upon the mechanical properties (tensile test) of rolled copper (Lewis, 268). Specimens were cast, rolled hot to ⅜ in. diameter and quenched.

Arsenic, per Cent	Tensile Strength, Lb./Sq. In.	Elastic Limit, Lb./Sq. In.	Elongation per Cent
0.00	26,800	14,000	25
0.24	33,800	20,000	27
0.53	36,800	19,000	29
0.75	36,600	18,000	21
0.94	36,000	18,000	25
1.37	37,700	20,000	28
1.80	35,700	23,000	20

TABLE VII—INFLUENCE OF ARSENIC ON MECHANICAL PROPERTIES OF ROLLED COPPER (BENGOUGH & HILL, 247)

Specimens prepared from B. E. R. copper and arsenic alloy poled, cast into 3-in. ingots, rolled at good red heat with one reheating and finished by drawing cold with one ⅜-in. pass to 1 in. and tested.

CHEMICAL ANALYSES ¹				PHYSICAL PROPERTIES				
Copper	Arsenic	Oxygen	Sulphur	Tensile Strength, ² Lb./Sq. In.	Yield Point, ² Lb./Sq. In.	Elongation in 2 In., ² per Cent	Reduction of Area, ² per Cent	Scleroscope No. ²
99.055	0.04	...	0.005	34,800	14,000	58	79	11-15
99.733	0.26	0.12	0.007	35,300	21,000	40	79	11.3
99.344	0.75	...	0.006	35,100	14,000	57	79	11.0
99.052	0.94	0.15	0.008	37,100	19,300	54	70	10.5
98.055	1.94	0.20	0.005	37,900	14,000	62	80	10.5

¹No trace found of lead, tin, or iron.

²Results are average of two tests.

According to these investigators arsenic in amounts up to 1.9 per cent causes, therefore, neither hot nor cold-shortness when, as usual, copper oxide is present, i.e., in tough-pitch copper. It seems that the presence of oxide affects the influence which arsenic exerts on copper. Roberts-Austen (275) find that 1 per cent arsenic begins to cause red-shortness in oxide-free copper. Jolibois and Thomas (262) state that 0.4 per cent arsenic causes cold-shortness in pure copper, whereas 0.4 per cent As₂O₃·Cu₂O does not.

Bauke has studied the effect of arsenic on the toughness of copper; see Table X.

"Arsenical" copper such as is used commercially for copper which must resist high temperatures, in locomotive fire boxes, etc., contains from 0.1 to 0.4 per cent of arsenic.

BISMUTH

The constitution of the copper-bismuth alloys has been studied by Jeriomin (204), Portevin (203) and others. The amount of bismuth taken up by copper in solid solution is practically zero; it has never been accurately determined.

Johnson (261) has investigated the effect of small amounts of bismuth on the tensile properties, ductility and malleability of tough pitch copper. His results are summarized in Table IX. His conclusions are:

"The effect of bismuth on the mechanical properties of 'tough' arsenical copper which has been rolled is not

serious up to 0.1 per cent; but no commercial arsenical copper could be regarded as fit for working at a red heat which contained so much bismuth. With 0.02 per cent, although the hot-working properties would be noticeably worse than if no bismuth were present, the copper would not be ruined. Any crude copper containing over 0.01 per cent bismuth should be regarded with suspicion, since the copper might contain traces of other impurities, e.g. nickel, which, while intensifying the injurious effect of bismuth, would hinder the corrective action of arsenic."

Johnson also concludes that an explanation of the less intense effect of bismuth on the hot-rolling properties of oxygen-bearing copper is due to its presence therein as Bi_2O_3 or combination thereof as isolated particles, whereas in overpoled or oxygen-free copper the bismuth is present as films of metallic bismuth, which, owing to its low melting point, destroys the cohesion of the mass at high temperatures.

Other investigators of this subject have been Roberts-Austen (275), Hampe (253), E. A. Lewis (269), Arnold and Jefferson (245). Roberts-Austen made oxygen-free, bismuth-bearing copper alloys which could not be worked at all over 0.1 per cent bismuth. Lewis comes to practically the same conclusions as does Johnson regarding allowable bismuth limits and shows that whereas arsenic corrects the ill effects of bismuth, they are intensified by manganese, tin, aluminium, etc.

IRON

The constitution of the alloys of copper with iron has been studied by Ruer and Fick (211), Sahmen (210), and others. Copper will take up 2 or 3 per cent of iron in solid solution. Within those limits iron hardens copper and diminishes its ductility.

LEAD

The constitution of the copper-lead alloys has been studied by Friedrich and Leroux (212), Heycock and Neville (213), and others. The amount of lead which copper will hold in solid solution is very small, probably much less than 0.1 per cent. No systematic study has been made of the effects of lead on the mechanical properties. Its effect on the working properties at high temperatures is dependent on the amount of arsenic or Cu_2O present; 0.1 per cent of lead would render pure copper unworkable, whereas with 0.3 or 0.4 per cent arsenic such a percentage of lead is not out of the question.

Archbutt (244) was able to forge oxide-free copper ingots containing 0.05 per cent lead and those containing 0.1 per cent lead and 0.4 per cent arsenic without cracking of the ingots.

Johnson (259) states that the mechanical properties of arsenical copper at ordinary temperatures are but slightly affected by the addition of lead. Rods prepared by him (see Table V for method of preparation) containing oxygen, 0.023; arsenic, 0.39; lead, 0.18 per cent, showed the following properties:

	Tensile Strength, Lb./Sq. In.	Elongation in 3 In., per Cent	Alternations to Rupture Arnold's Test
As rolled	41,200	17.3	169
As annealed	32,900	53.3	238
Original electrolytic copper			
As rolled	44,400	14.7	118
As annealed	32,000	51.3	244

The ingot of this leaded copper rolled well (see Table V for description of rolling), whereas one containing

0.012 per cent oxygen, 0.38 per cent arsenic, and 0.35 per cent lead cracked at first pass.

MANGANESE

The constitution of the alloys of copper and manganese is discussed by Sahmen (219), Schemtun, Urasow and Rykowski (218), and others. Copper and manganese form a continuous series of solid solutions.

Münker (273) gives results of tests of alloys of copper and manganese (see Table VIII), from which it is seen that manganese in small amounts hardens copper and diminishes its ductility.

Bauke has studied the effect of manganese on the toughness of copper (see Table X).

TABLE VIII—EFFECT OF SMALL ADDITIONS OF MANGANESE, PHOSPHORUS, AND TIN ON THE MECHANICAL PROPERTIES OF COPPER (MÜNKER, 273)

Composition	AS COLD-ROLLED, UNANNEALED			ANNEALED AT 500° C.					
	Ultimate Strength, Lb./Sq. In.	Elongation in 2 In., per Cent	Brinell Hardness Numeral	QUENCHED IN WATER			SLOWLY COOLED		
				Ultimate Strength, Lb./Sq. In.	Elongation in 2 In., per Cent	Brinell Hardness Numeral	Ultimate Strength, Lb./Sq. In.	Elongation in 2 In., per Cent	Brinell Hardness Numeral
B. E. R.	52,300	4.24	94	34,100	46.07	74	32,500	46.64	63
Phosphorus ¹									
0.014%	52,900	4.04	96	35,100	45.06	74	32,700	46.54	63
0.042	55,300	3.89	101	35,800	44.10	74	32,800	45.84	65
0.092	57,000	3.43	112	35,900	42.98	74	33,600	44.80	68
0.173	57,800	3.33	118	36,600	41.44	74	34,600	41.70	70
0.399	60,500	3.27	130	37,400	39.81	77	36,300	40.74	74
0.563	66,200	2.46	145	41,200	39.74	84	38,500	40.02	77
1.062	75,900	2.28	160	46,800	38.14	96	41,000	39.87	84
Manganese ²									
0.04	52,400	4.14	94	34,200	45.13	77	32,600	45.69	74
0.07	53,300	3.97	96	34,400	44.44	77	33,200	44.72	74
0.12	54,000	3.94	96	34,300	44.22	77	33,900	44.52	74
0.19	54,600	3.94	96	34,600	44.06	77	33,500	44.15	74
0.29	55,400	3.97	99	34,800	43.97	77	34,500	44.43	77
0.40	56,100	4.02	99	35,500	43.98	77	34,700	44.31	77
0.61	56,400	3.99	99	35,800	43.22	81	34,900	44.38	81
0.98	58,400	4.09	106	37,600	42.94	84	36,700	44.41	84
1.34	63,200	3.98	112	40,000	40.59	88	38,500	42.58	84
1.49	64,400	4.12	118	40,700	39.93	94	39,000	40.56	88
Tin ³									
0.13	56,300	3.02	106	36,600	43.24	81	35,100	43.97	79
0.24	57,100	3.03	106	37,400	43.01	81	35,900	43.22	81
0.32	60,000	2.91	106	38,600	42.81	81	36,300	43.05	81
0.40	62,300	2.99	118	38,200	42.37	84	36,200	43.08	84
0.53	62,700	3.09	118	38,600	42.24	84	37,000	42.68	84
0.62	63,500	2.95	118	40,100	42.14	90	38,200	42.32	86
0.88	64,800	2.89	125	40,500	41.94	92	38,100	42.10	86
1.15	66,200	2.90	130	40,600	41.75	96	39,300	42.39	88
1.24	67,600	2.84	136	42,800	41.73	96	40,900	42.26	92
1.46	69,600	2.67	145	44,700	40.97	101	41,700	41.35	96

¹The alloys were made under commercial conditions with B. E. R., copper and additions of phosphorus-copper, tin-copper, and manganese-copper. The cast slabs were first hot rolled and then finished cold. Samples were annealed at 500° C. and either quenched or slowly cooled. The tensile tests were carried out on strips 3 mm. thick, 15 mm. wide, of a test length of 11.5 $\sqrt{\text{area}}$ section, or about 75 mm. The Brinell tests were made with a load of 500 kg. and a ball of 5 mm. diameter.

²The phosphorus alloys were otherwise as pure as the original B. E. R. copper; the manganese and tin alloys contained also from 0.012 to 0.020 per cent of phosphorus.

NICKEL

The constitution of the nickel-copper alloys has been studied by Guertler and Tammann (220), Tafel (222), and others. The two metals form a continuous series of solid solutions.

Small additions of nickel harden copper and diminish the ductility slightly, but apparently increase its toughness; see Table X (Bauke).

(To be continued)

Aluminium in 1917.—The value of primary aluminium made in the United States in 1917, according to the Geological Survey, was \$45,882,000, an increase of \$11,982,000 over the value of that made in 1916. This increase appears to be due chiefly to an increase in the quantity of metal produced.

Fats and Fatty Acids from Petroleum

BY ROBERT J. MOORE AND GUSTAV EGLOFF

IN considering the subject of the transformation of one class of oils into another of greater economic value, it seems advisable, as an introduction, to review the main classes into which "oily" matter in general may be divided. These classifications may be made first, through their physical properties and occurrence, and, second, by their chemical structure.

The term oil includes a vast number of substances, both natural and artificial, possessing widely different physical properties and chemical structure. All substances included in this term are practically insoluble in water, possess a characteristic greasy touch and have a low surface tension. This latter property forms the basis of the well-known definition that "an oil is a substance which, when dropped on paper, forms a translucent spot which is not removable by washing with water."

By the action of boiling alkali solutions we are able to separate oils into two large groups. One group splitting into fatty acids and free glycerine, a process which is called saponification, while the other group is not affected. The saponifiable oils are divided into animal oils and vegetable oils, depending on their origin. The vegetable oils are further classified according to physical properties into drying, semi-drying and non-drying oils and solid fats. The unsaponifiable oils are subdivided into mineral oils, which constitute the vast amount of petroleum and shale oils; rosin oils, tar oils and ethereal oils. The complete general system of classification is shown in the accompanying diagram.¹

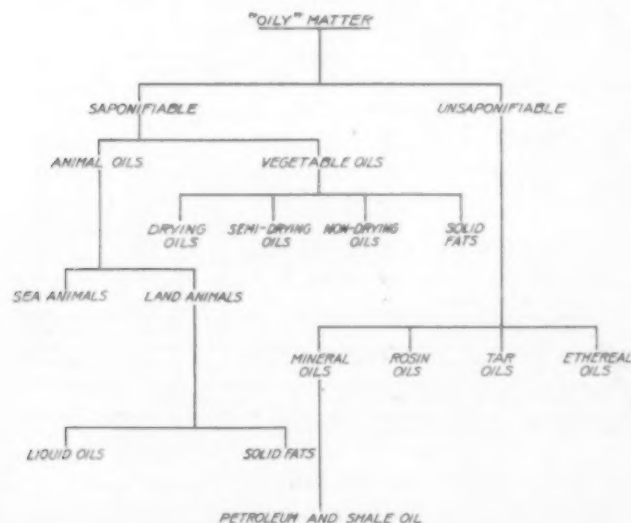
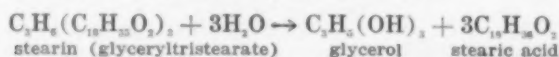


FIG. 1. CLASSIFICATION OF OILS

The naturally occurring animal and vegetable fats and oils consist essentially of mixtures of glycerides. Fats and glycerol esters of fatty acids when hydrolysed yield free glycerol and fatty acid, thus:



Since the glycerol radical is common to all, the nature of the fat depends upon the acid with which the glycerol is combined. These acids may be of the following groups:

Series $\text{C}_n\text{H}_{2n}\text{O}_2$

Under this series occur

Butyric acid $\text{C}_4\text{H}_8\text{O}_2$ in butter.

Caproic acid $\text{C}_6\text{H}_{12}\text{O}_2$ in goat and cow butter, coconut fat.

Caprylic acid $\text{C}_8\text{H}_{16}\text{O}_2$ in human fat, butter, coconut oil.

Palmitic acid $\text{C}_{16}\text{H}_{32}\text{O}_2$ in many fats and oils.

Stearic acid $\text{C}_{18}\text{H}_{36}\text{O}_2$ in most fats.

Series $\text{C}_n\text{H}_{2n-2}\text{O}_2$

Oleic acid $\text{C}_{18}\text{H}_{34}\text{O}_2$ is present in nearly all fats and fatty oils.

Other series, such as $\text{C}_n\text{H}_{2n-4}\text{O}_2$, $\text{C}_n\text{H}_{2n-6}\text{O}_2$ and $\text{C}_n\text{H}_{2n-8}\text{O}_2$, are found as glycerides in some of the fats; for example, linoleic acid ($\text{C}_{18}\text{H}_{32}\text{O}_2$) and linolenic acid ($\text{C}_{18}\text{H}_{30}\text{O}_2$) are found in linseed oil and other drying oils.

While small percentages of these free fatty acids may occur in the oils and fats, the main constituent is the glycerol ester. Thus we have tributyrin in butter fat, tripalmitin in palm oil, triolein and tristearin in most fats and oils.

THE MINERAL OILS

The chief division under the second general group of oils called unsaponifiable is the mineral oil division, embracing all petroleum and shale oils, and is the division to which we will, for the present, confine our attention. Petroleum oils are found widely disseminated in nature, the most important fields being the California, Texas, Mid-Continent, and the Eastern fields in the United States; the Russian, Galician, Roumanian and Italian in Europe, and the Mexican fields, which are now being rapidly developed. There are, besides these many productive districts in Asia and the East Indies. The world's production² for 1915 was 427,695,347 barrels, of which the United States produced 65 per cent. Russia ranks next in production and Mexico third. The total output for 1916 amounted to 460,639,000 barrels.

The hydrocarbons composing petroleum differ widely in nature. The Eastern oils are almost entirely of the paraffin or saturated series, the Mid-Continent semi-asphaltic, the California and Texas oils contain compounds mostly of the asphaltic type, while the Russian and Galician fields are mainly naphthenic.

The accompanying Table I contains hydrocarbons, homologs of which have been isolated in crude oil from the various fields:

TABLE I		
Name	Formula	Occurrence
Paraffins	$\text{C}_n\text{H}_{2n+2}$	Pennsylvania; some in other American oils, only small percent in Russia.
Olefins	C_nH_{2n}	In Canadian and California oils. To small extent in Pennsylvania and other oils.
Naphthenes	C_nH_{2n}	Predominate in Russian oils, Franklin oils of Pennsylvania. Found to small extent in other crudes.
Asphaltic	$\text{C}_n\text{H}_{2n-4}$	In Texas and California oil.
Acetylenes	$\text{C}_n\text{H}_{2n-2}$	Baku oils in small amount.
Benzenes	C_6H_6	To some extent in most crudes fair percent in California oils.
Phenylethenes	C_8H_{10}	Slight extent; uncertain.
Phenylethines	C_8H_{10}	Slight extent; uncertain.
Naphthalenes	C_{10}H_8	Slight amounts in Rangoon oils.

The hydrocarbons which we are mainly interested in for present purposes are the paraffins, the naphthenes and the olefins. Our interest from now on will be directed to the many methods that have been offered for preparing fats and fatty acids from the above type hydrocarbons in petroleum oils.

¹Southcombe's "Chemistry of the Oil Industries."

²Petroleum in 1915, J. D. Northrop.

CONVERSION OF PETROLEUM HYDROCARBONS TO FATS AND FATTY ACIDS

The past work on this subject, all of which is of rather recent date, may be divided for simplification of narrative into four different methods:

- 1.—Through halogenation of aliphatic hydrocarbons.
- 2.—By way of Grignard's reaction.
- 3.—By way of naphthenes.
- 4.—Through direct oxidation of paraffins or olefins.

1. THROUGH HALOGENATION

In considering the problem of forming fatty acids from paraffins, the simplest method that might appeal to us is the conversion of a methyl group, of a boiling point in the neighborhood of 300 deg. C. into the carboxyl group. Thus hexadecane $\text{CH}_3(\text{CH}_2)_{14}\text{CH}_3$ boiling point 287.5 deg. C. might be oxidized to $\text{C}_{15}\text{H}_{31}\text{COOH}$ (palmitic acid) by the mere conversion of one methyl into a carboxyl group. The introduction of halogen into the paraffin seems to offer the most feasible first step in this reaction, and has been the subject of many patents. The Badische Anilin & Soda Fabrik¹ produce halogen derivatives of the paraffin series by mixing the oil and the halogen in the dark, vaporizing and subjecting the mixture to the action of the silent electric discharge. Halogenation takes place immediately. Pfeifer & Szarvasy² also use the silent discharge to effect the reaction, while Ellis³ uses ultraviolet light for the halogenation of various hydrocarbons.

The writers, in a series of preliminary experiments, passed vaporized kerosene and chlorine, after heating, into an electrical silent discharge field of high potential, adding carbon dioxide at the same time. The experiments, though preliminary in nature, showed an increased specific gravity in the oil and a tendency to emulsify with sodium hydroxide solution. Indications are that a certain amount of fatty acids are formed under these conditions, the data of which will be given in a later communication. Further work along these lines is in progress.

H. Strauss⁴ produces monochlor compounds of the higher hydrocarbons of petroleum by treating in the gas phase, under reduced pressure, with chlorine. Information is lacking as to just how oxidation is effected, whether directly to acids or by way of alcohols and aldehydes.

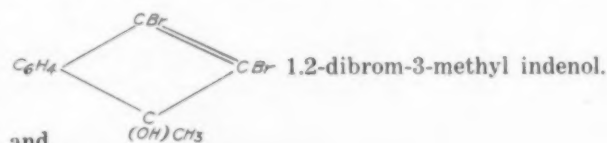
As in most work on commercial problems of this sort, very little is stated as to details and yields. It is, however, quite possible to prepare fatty acids by this method, although its economic success probably depends upon further research.

2. BY GRIGNARD'S REACTION⁵

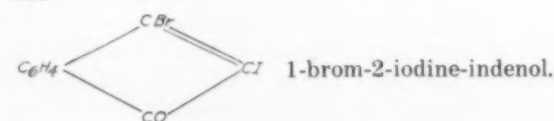
Zelinski⁶ found that the reaction between magnesium and chlorinated hydrocarbons may be rendered complete by the addition of a catalytic agent such as iodine,

aluminium halides or hydrochloric acid. He chlorinated the petroleum, dissolved it in anhydrous ether and treated this mixture with metallic magnesium and the catalyst. Subsequently, when cold, a current of carbon dioxide was passed through, decomposing the complex magnesium compound thus obtained. The fatty acids were then liberated from the magnesium compounds by dilute acid. Zelinski claims for this method a yield of 60 per cent of the theoretical. Pentane yielded isohexanoic acid. A naphthene fraction (80-82 deg. C.) yielded cyclohexanecarboxylic acid, while a naphthene (71-79 deg. C.) yielded heptonic, methylcyclopentanecarboxylic and cyclohexanecarboxylic acids. He succeeded in synthesizing acids containing up to ten carbon atoms in the molecule, and in preparing a di- and tri-octin from an acid of the Formula $\text{C}_8\text{H}_{14}\text{O}_2$ belonging to the same group as oleic acid, by heating the fatty acid with glycerine to 250 deg. C. While it is true that acids with more than ten carbon atoms show an essentially different action chemically from that of the lower fatty acids, still, if the lower acids may be so readily prepared, the synthesis of the higher acids is merely a matter of degree, which further research should make possible. Moreover, hydrogenation of unsaturation of unsaturated acids and bromine substitution is being rapidly improved, as a glance at recent patent literature will show, and the transformation to higher or lower acids is becoming more and more a commercial practice. The Vereinigte Chem. Werke of Charlottenberg has made a special problem of hydrogenation and has conducted it on an enormous scale, using a temperature of 100 deg. C. with 2 to 3 atmospheres pressure and 0.00002 parts of palladium chloride in an alkali as catalyst. In 1914 they predicted⁷ that the synthetic production of fatty acids and fats from hydrocarbons by the process of Zelinski⁸ was commercially feasible, but that the cost of the product was then still too high. Since the beginning of the war nothing authoritative has been published as to the German industries, but it is not improbable that Germany to-day is supplying a large part of her fats from synthetic production.

Bjelous⁹ uses the Grignard reaction for the production of alcohols from olefins. This reaction is also used by Simmonis and Kirschten,¹⁰ who have isolated and determined the composition of many halide compounds which may readily yield acids. Among these we find



and



3. BY WAY OF NAPHTHENES

Naphthenes form the bulk of the Russian and Galician oils, and much experimenting has been done by Russian chemists on cracking and other forms of treatment of these hydrocarbons. Many investigators have

¹Eng. Pat. 5125, 1912.

²U. S. Pat. 1012, 149.

³U. S. Pat. 1146, 142.

⁴Germ. Pat. 267, 204 (1912).

⁵Grignard's reaction employs metallic magnesium, the alkyl halide and anhydrous ether. The magnesium dissolves forming an alkyl magnesium halide as CH_3MgBr . When CO_2 is passed through this the addition product $\text{CH}_3\text{CO.O.MgBr}$ is formed which upon hydrolysis yields the acid, thus:

$\text{CH}_3\text{CO.O.MgBr} + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{COOH} + \text{Mg(OH)Br}$

For further consideration of this reaction see Hewitt and Steinberg, *Proc. Chem. Soc.*, 1912, 140; Zaretwinoft, *Ber.*, 1912, 2384; Hibbert, *Proc. Chem. Soc.*, 1915, 15; Simmonis and Kirschten, *Ber.*, 1912, 568.

⁶Germ. Pat. 151, 880; *Ber.* 1912, 2687; *Chem. Zeit. Rep.* 1909, 631.

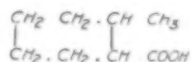
⁷See M. Colletas, *Mat. Grass.*, 7, 4153, 1914.

⁸Loc. cit.

⁹*Ber.*, 1912, 627.

¹⁰*Berichte*, 1912, 568.

found that a certain amount of oxygen is present in these oils as naphthenic acids. Markownikoff has isolated octanaphthenic acid,



and hexa, hepta, nono and deka naphthenic acids have been obtained from the alkali washings. E. Pyhalla¹² finds these acids present to about 0.9 per cent in Russian oils and suggests that they be neutralized with caustic soda, before refining, and made into soaps. He finds also¹³ that the fraction of Baku petroleum boiling between 98 deg. and 106 deg. C. yields up to 20 per cent of its weight of adipic acid, which, by way of its amide, can be converted into butadiene and synthetic butadiene rubber. Pyhalla suggests that if these butadiene hydrocarbons could be isolated from the petroleum by a simple, direct process, this route to synthetic rubber would be a good one.

The production of glycerides from these free naphthenic acids is readily accomplished, but the resulting fat shows characteristic differences in properties from natural fats. The naphthenic fats are heavier than water (specific gravity 1.008 at 15 deg. C.), and tend to form plastic masses. This latter property has led to many patents for the production of India rubber substitutes, one of the most promising of which is Chercheffsky's.¹⁴

Naphthenes lend themselves to the Grignard reaction as readily as paraffins and have been used in Zelinsky's experiments.

4. DIRECT OXIDATION OF PARAFFINS AND OLEFINS

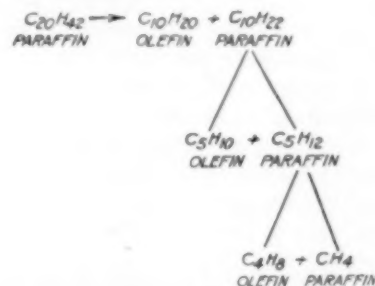
Probably the most direct method of synthesizing the fats, and the method which, at the same time, seems to be of commercial significance, is the oxidation of paraffins and olefins to acids. This may be accomplished by air or other oxidizing agents and by way of alcohols or aldehydes. That the oxidation of even so inert an oil as paraffin vaseline can be made to yield acids is shown by the work of Benedix.¹⁵ He intimately mixes the oil, in the presence of water, with sodium peroxide or hydrogen peroxide, diluted with alkalis and alkaline salts. After being stirred for some time, the mass thickens and part of the hydrocarbon is oxidized to acids, which combine with the alkali present to form soaps. The reaction is promoted by the addition of alcohol, and by heating to about 80 deg. C. under pressure. The resulting product is in the form of a soft paste, which "may be readily distributed in water and possesses great detergent power."

Schultz¹⁶ by passing a rapid current of air through burning paraffin oil or hot lubricants obtained chiefly aldehydes, carbon monoxide and a small quantity of acids, but his work was rather crude and inadequate. Two recent patents,¹⁷ couched in identical terms, are highly promising. In these experiments paraffin wax, in a molten condition, is treated with a blast of air or oxygen for a prolonged period, at a temperature of 100 deg. C. to 120 deg. C. The color changes to light red, light yellow and finally to a deep yellow. At this

stage about 70 per cent of the wax has been converted into fatty acids, and a small quantity of alcohols, formaldehyde and the like. The different products are separated by distillation and the unchanged wax re-treated. Mercuric oxide or wax that has already been treated may be used as catalysts. By this process it seems possible to convert some 80 to 90 per cent of paraffin wax into fatty acids. The significance of this is readily appreciated. Moreover, Gray's experiments¹⁸ seem to offer almost equally as favorable results. Gray blows air through the oil, at the same time subjecting to the actinic rays of ultraviolet light. With the assistance of heat (90-175 deg. C.), pressure and catalysts, such as finely divided metals, he converts part of the oil into fatty acids. With a lower temperature this process is used for the deblooming of certain paraffin oils.

Both of the above patents treat paraffin oils, which are saturated compounds and decidedly stable. It would seem advisable, therefore, to use as a starting material olefins which are unsaturated in structure and much more readily oxidized to acids. Olefins are not found to any considerable extent in natural petroleum, but a glance at the literature will show that they are readily obtained from petroleum in many ways.

Thorpe and Young¹⁹ found that paraffins on being distilled under pressure at high temperature are decomposed into liquid hydrocarbons of the ethylene and methane series. Among the former were found up to nonylene. The general type of the so-called cracking reaction is as follows:



Gawalowski²⁰ finds that paraffins on prolonged heating alone yield gaseous and liquid products of the ethylene and acetylene series. Armstrong and Miller,²¹ in investigating the by-products from the manufacture of Pintsch gas, found a high percentage of olefins up to crotonylene. The tars recovered from cracking Russian petroleum were found²² to contain large amounts of hexylene and heptylene. Egloff and Moore²³ were able to prepare from 4 per cent to 95 per cent of olefins in the gasoline cuts from cracked paraffin oils by varying temperature and duration of reaction. In general, "high temperature of cracking makes for high unsaturation."²⁴

Since the olefins are so readily obtainable from paraffin oils, and since they are readily oxidized, they offer an inviting field for experimentation. Greenstreet's²⁵ work upon this subject has led to the production of alcohols and fatty acids. He passes mineral oils mixed with steam through long coils of pipe heated to a cherry red,

¹²Petroleum, 9, 1506 (1914).

¹³Neftanoje Djele, 1913, No. 17; Pet. 9, 1376, 1914.

¹⁴Germ. Pat. 228, 858.

¹⁵Fr. Pat. 446,009, July 12, 1912.

¹⁶Eighth Int. Cong. App. Chem., 10, 273.

¹⁷Schmidt, Eng. Pat. 109,386; Feb. 13, 1917. Hulsberg and Selle; Swiss Pat. 75,653; Sept. 1, 1917.

¹⁸U. S. Pat. 1,158,205; Oct. 26, 1915.

¹⁹Liebig Ann. 165, 25.

²⁰Oesterr. Chem. Tech. Z., 70, 1910.

²¹J. Chem. Soc. 49, 74, 1886.

²²Lewes, J. Soc. Chem. Ind., 11, 584, 1892.

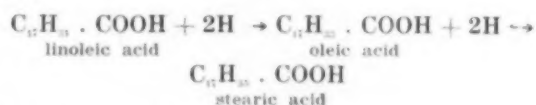
²³Met. & Chem. Eng., 15, 9, 1916.

²⁴Hall, Inst. Pet. Techn., 1915.

²⁵U. S. Pat. 1,110,925, Sept., 1914.

thus cracking to olefins. The olefins are then oxidized and the products separated by fractional distillation. Oxidation may be effected by treatment with sulphuric acid to convert to the corresponding sulphuric ethers and then converted by water to alcohols. Or the olefins may be oxidized directly to aldehydes and acids by permanganate or chromic acid solution.

It is apparent from the foregoing work that fatty acids of various types may be prepared from petroleum hydrocarbons, in commercial quantities. Since, therefore, it is practicable to prepare certain fatty acids from petroleum, the question of changing to higher or lower acids, or from unsaturated to saturated acids, is being successfully answered in many recent patents, notably those of C. Ellis. Hydrogenation may alter acids as follows:



The carbon chain of fatty acids may also be broken down in many ways. A new method of accomplishing this is brought forth by Levene and West.²⁷ It consists in transforming the high fatty acid into its alpha-hydroxy-acid, which is then oxidized in hot methyl acetate with potassium permanganate. The potassium salt of the new acid is insoluble in the methyl acetate and precipitates, together with manganese dioxide, from which it is separated by hot alcohol. By this method Levene and West were able to obtain from stearic acid 80 to 85 per cent of margaric acid. Lignoceric and pentadecylic acids were also formed from cerebronic and palmitic acids respectively.

It seems feasible, therefore, to prepare a fatty acid from petroleum oils that will have the same composition as an acid derived from natural fats. Or the acid formed may be so shifted by hydrogenation, or by breaking down the carbon chain, as described above, so as to finally produce the acids as found in natural fats.

The fats themselves, which are the glycerol esters of these fatty acids, may be readily prepared on a large scale by combination with glycerol. For this purpose may be employed such methods as heating with glycerol to 220 deg. C. under pressure,²⁸ by the action of Twitchell's reagent (sulpho-aromatic compound) on the acid and glycerol,²⁹ or by the action of enzymes.

The importance of the conservation and production of fats in this catastrophic period in world history can be gleaned from the following shortage and further developing shortage of livestock throughout the world.³⁰ The German army has taken from Belgium and France 1,800,000 head, and the herds of France had already decreased a year ago 16.6 per cent. To-day France is producing only one gallon of milk where two and one-half were produced before the war. The Allies, excepting the United States, have reduced their stock of cattle, sheep and hogs to the extent of 33,000,000 head since 1914 and the world stock to the extent of 115,000,000 head. According to Mr. Hoover, the per cent of hogs slaughtered in the fiscal year 1916-1917 was 96, while 86 per cent was slaughtered in 1916, and furthermore the average weight had fallen from 219 to 211 pounds

per hog. In short, at the present time we have approximately 5,000,000 hogs less than our normal supply. The supply of cattle and sheep has been similarly affected hence it behooves us to search for commercial synthetic methods for the production of fats.

The foregoing work shows the extent to which the synthetic production of fats and fatty acids from hydrocarbons present in petroleum oil has been successful. Further work along the lines indicated by the writers is being carried on and will be reported upon in a later paper. It may be stated, however, that the collective work shows a considerable degree of success, and that "fats and fatty acids from petroleum" is more than an empty phrase.

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Another Source of Toluol

Every possible source of toluol is being investigated by the War Department. It was brought out at the meeting of the Technical Association of the Pulp and Paper Industry on Feb. 6 and 7 in New York that toluol can be produced from spruce turpentine, which is an oil formed during the cooking of the chips in sulphite digesters, which escapes with the steam in the blowing out process, and is generally allowed to go to waste, though processes of recovering this crude form of turpentine are carried out in a few mills.

A representative of the War Department, Milo R. Maltbie, was present at the meeting on Feb. 7 and explained the need for toluol and stated that it was understood that 300,000 gallons could be obtained from the mills in the United States at very little expense to the mills. He pointed out that it was a patriotic duty for all the mills to install the apparatus to recover this spruce turpentine and ship it to a central refining plant if the War Department finds it desirable after its investigation. A committee of the Technical Association was appointed to co-operate with the War Department in ascertaining the supplies of spruce turpentine that are available for toluol manufacture.

While the total quantity of toluol as estimated by Mr. Maltbie is not large, considering that he stated that he had put 3,000,000 gallons under contract during the last six weeks, still every available gallon helps and all sources must be developed.

Domestic Tin Production.—A report by Adolph Knopf of the Geological Survey gives the production of metallic tin of domestic origin in 1916 as 140 short tons. The ore was derived almost wholly from Alaska. The bulk of the concentrate was shipped to Singapore, but part was sent to the tin-smelting plant of the A. S. & R. Co., at Perth Amboy, N. J. The total importation was 74,619 tons and tin recovered from drosses 17,400 tons. Nevada, the Carolina tin belt and the Black Hills of South Dakota have been prospected with no definite production as yet announced. The production of tin (mostly from Bolivian concentrate) at Perth Amboy in 1917 was about 6000 tons. It is expected to be increased in 1918 to 10,000 tons. The National Lead Company's new plant is also producing tin, but actual figures for 1917 are not yet available. The production of this American tin has helped considerably at a time when foreign tin has been hard to obtain.

²⁷J. Biol. Chem. 16, 475.

²⁸Belucci, *Gaz. Chim. Ital.* II, 283, 1912.

²⁹Krause, *J. Soc. Chem. Ind.*, 633, 1911. Iwanow, *Ber. Deut. Botan. Ges.*, 595, 1911.

³⁰New Republic, Feb. 2, p. 13, 1918.

A Bibliography of Alloys

Binary, Ternary and Quaternary Systems Whose Equilibria Have Been Investigated

BY CLARENCE ESTES

IN A PREVIOUS article¹ the writer gave a bibliography of the binary, ternary and quaternary systems of alloys whose equilibria had been investigated and published in *Chemical Abstracts* to Jan. 1, 1917, and the more important investigations published prior to the publication of that magazine.

The following bibliography is to supplement the original article. It includes the articles on the equilibrium system of alloys, abstracted and published in *Chemical Abstracts* from Jan. 1, 1917, to Jan. 1, 1918.

The number preceding a system refers to the list of references in the original article.

BINARY SYSTEMS

No.	System	Chemical Abstract	Journals in Which Original Articles Were Published.
	Ag-Be	1917, 2630	J. Chem. Soc., 112, II, 89
9	Ag-Cu	1917, 2851	Phys. Rev., 9, 156
18	Ag-Pt	1917, 2851	Phys. Rev., 9, 156
24	Ag-Te	1917, 447	Mem. Coll. Sci. Kyoto Imp. Univ., 1, 361
	Al-Be	1917, 2630	J. Chem. Soc., 112, II, 89
37	Al-Cu	1917, 2884	Metal Ind., 15, 340
38	Al-Fe	1917, 3229	Univ. Ill. Eng. Expt. Sta., 95
79	Au-Mn	1917, 2442	Z. anorg. allgem. Chem., 95, 105
	Be-Cu	1917, 2630	J. Chem. Soc., 112, II, 89
	Be-Fe	1917, 2630	J. Chem. Soc., 112, II, 89
115	Bi-Sn	1917, 934	Z. anorg. allgem. Chem., 98, 97
120	C-Fe	1917, 3225	Trans. Iron Steel Inst., 1917
		1917, 3225	Eng. Expt. Sta., Pa., Bull. No. 18
		1917, 3222	J. Russ. Met. Soc., 3, 112, 148
		1917, 3220	Trans. Iron Steel Inst., 1917
		1917, 2887	Sci. Rep. Tahoka Imp. Univ., 6, 23
		1917, 2883	Bull. Am. Inst. Mining Eng., 1917, 1365
		1917, 2882	Compt. rend., 165, 172
		1917, 2882	Compt. rend., 165, 182
		1917, 2881	Compt. rend., 164, 885
		1917, 2881	Compt. rend., 164, 1005
		1917, 2878	Phys. Rev., 9, II, 228
		1917, 2768	J. Russ. Met. Soc., 3, 78
		1917, 2767	J. Iron Steel Inst., 44, 210
		1917, 2766	Proc. Roy. Soc. London, 93 (A), 313
		1917, 2765	Compt. rend., 165, 59
		1917, 2451	Proc. Tokyo Math. Phys. Soc., 9, (II), 112
		1917, 2449	Proc. Tokyo Math. Phys. Soc., 9 (II), 109
		1917, 2448	J. Russ. Met. Chem. Soc., 3, 150
		1917, 1945	J. Iron Steel Inst., 1917
		1917, 442	Proc. Am. Soc. Testing Materials, 16, II, 5
		1917, 27	Iron Steel Inst., 1916
		1917, 26	Iron Steel Inst., 1916
147	Cd-Sn	1917, 934	Z. anorg. allgem. Chem., 98, 197
	Ce-Co	1917, 2890	J. Chem. Soc., 110, II, 35
	Ce-Fe	1917, 3229	J. Chem. Soc., 112, II, 259
156	Co-Fe	1917, 1947	Can. Dept. Mines, Mines Branch, 1916
167	Cr-Cu	1917, 2442	Univ. Ill. Eng. Exp. Sta. Bull., 93
180	Cu-Ni	1917, 2879	Metall. u. Erz., 14, 21
		1917, 2442	Univ. Ill. Eng. Exp. Sta., Bull., 93
		1917, 775	Metal Ind., 15, 72
181	Cu-P	1917, 3228	Metal Ind., 15, 386
186	Cu-Sb	1917, 3153	J. Russ. Phys. Chem. Soc. (Proceed.), 48, 700
		1917, 3153	J. Russ. Phys. Chem. Soc. (Proceed.), 48, 701
		1917, 1124	Rev. metal., 12, 405
189	Cu-Sn	1917, 2889	Foundry, 45, 155
194	Cu-Zn	1917, 2889	Foundry, 45, 155
197	Fe-Ni	1917, 2882	Compt. rend., 164, 904
	Fe-Ni	1917, 2882	U. S. Bureau Standards, Circ., 38
211	Hg-K	1917, 553	Proc. Nat. Acad. Sci., 2, 634
212	Hg-Li	1917, 553	Proc. Nat. Acad. Sci., 2, 634
214	Hg-Na	1917, 553	Proc. Nat. Acad. Sci., 2, 634
254	Mn-Sb	1917, 2888	Sci. Rept. Tahoka Imp. Univ., 6, 9
	Se-Tl	1917, 143	Mem. Coll. Sci. Kyoto Imp. Univ., 1, 153

BIBLIOGRAPHY OF THE TERNARY SYSTEMS

24	B-Fe-Ni	1917, 3228	Rev. soc. russe metal., 1, 547
	C-Co-Fe	1917, 2449	Proc. Tokyo Math. Phys. Soc., 9, II, 106
25	C-Cr-Fe	1917, 2450	Elektrochem. Z., 37, 592
26	C-Fe-Mn	1917, 3221	Compt. rend., 165, 334
		1917, 2766	Compt. rend., 165, 62
27	C-Fe-Mo	1917, 2451	Proc. Tokyo Math. Phys. Soc., 9 (2), 112

28	C-Fe-Ni	1917, 29	Proc. Inst. Mech. Eng., 1915, 701
		1917, 3221	Compt. rend., 165, 334
		1917, 2887	Arch. Sci. Phys. Nat., 43, 453
		1917, 2886	Iron Age, 100, 67
		1917, 2878	Phys. Rev., 9, II, 228
		1917, 2768	Iron Age, 100, 594
		1917, 2451	Proc. Tokyo Math. Phys. Soc., 9, II, 112
		1917, 2449	Proc. Tokyo Math. Phys. Soc., 9, II, 106
		1917, 1125	Atti. accad. sci. Torino, 51, 67
		1917, 26	Phys. Rev., 7, 685
		1917, 26	Phys. Rev., 7, 684
	C-Fe-O	1917, 26	Verslag. Akad. Wetenschappen, 25, 10
29	C-Fe-P	1917, 444	Iron Age, 98, 1286
		1917, 26	Iron Steel Inst., 1916
30	C-Fe-S	1917, 444	Iron Age, 98, 1286
		1917, 26	Iron Steel Inst., 1916
32	C-Fe-Si	1917, 2883	Bull. Am. Inst. Mining Eng., 1917, 490, 991
		1917, 1624	J. Chem. Soc., 110, II, 623
		1917, 26	Iron Steel Inst., 1916
35	C-Fe-W	1917, 2887	Sci. Rep. Tohoku Imp. Univ., 6, 23
		1917, 2766	Sci. Rep. Tohoku Imp. Univ., 6, 53
		1917, 2451	Proc. Tokyo Math. Phys. Soc., 9, (II), 112
35	C-Fe-W	1917, 2450	Elektrochem. Z., 37, 592
44	Cr-Cu-Ni	1917, 2442	Univ. Ill. Eng. Exp. Sta., Bull. 93
	Cu-Ni-W	1917, 2879	Metall. u. Erz., 14, 21

BIBLIOGRAPHY OF THE QUATERNARY SYSTEMS

	C-Cr-Fe-Ni	1917, 3223	Met. Chem. Eng., 17, 473
		1917, 2878	Proc. Am. Phys. Soc., 46, 353
	C-Fe-Mo-Ni	1917, 2451	Proc. Tokyo Math. Phys. Soc., 9, II, 112

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M	Ni	1917, 2878	Phys. Rev., 9, II, 255
N	P	1917, 2848	Chem. Weekblad, 14, 180
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Increasing Magnesite Production.—Until 1915 the United States produced only about 10,000 tons of magnesite annually, although it used 300,000 tons. The domestic supply came from California and the imported material came from Austria, Hungary and Greece. In 1916 the production in California jumped to 150,000 tons, but the imports, if the calcined material is computed as crude rock, fell to 93,000 tons. The supply, therefore, fell short of the demand. Manufacturers of open-hearth steel had difficulty in getting enough magnesite brick to line their furnaces, and companies that made magnesite flooring were short of raw material.

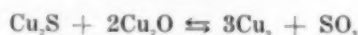
In view of this condition and the decrease in imports, domestic production was greatly stimulated. According to estimates by C. G. Yale of the United States Geological Survey, the production of magnesite in California in 1917 exceeded that of all former years, being estimated at 215,000 tons. This quantity and the magnesite produced in the recently discovered field in Stevens County, Wash., estimated by R. W. Stone of the United States Geological Survey, at close to 100,000 tons, makes an output of about 315,000 tons in 1917.

¹This Journal, Vol. XVI, No. 5, p. 273.

Synopsis of Recent Metallurgical and Chemical Literature

Copper

The Separation of Copper During the Concentration of Copper Matte.—If during the concentration of ferruginous copper matte in the reverberatory furnace the copper content rises above 73-74 per cent, then, according to an article published by W. STAHL in *Metall. u. Erz*, 1917, vol. XIV, pp. 201-202, there is an increase in the separation of copper which normally takes place according to the reaction process:



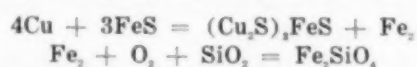
On adding a crude matte with a high ferrous sulphite content to a molten batch of enriched copper matte, there frequently occurs a special separation of copper which, in the further course of the concentration process, again disappears and is in no way connected with the above reaction. Again on smelting crude copper matte high in iron in the blast furnace there is frequently a separation of iron which is partly dissolved by undecomposed FeS. When the crude copper matte arrives in the crucible part of the dissolved iron will liberate copper from the slag according to the equation:



The remainder of the dissolved iron forms the solid compound $(\text{Cu}_2\text{S})_2\text{FeS}$, with separation of copper, thus:



This reaction is not in contradiction with the Fournet series. The energy of combination of Cu_2S is known to be greater than that of FeS, yet the energy of combination of the sulpho-salt $(\text{Cu}_2\text{S})_2\text{FeS}$ is apparently greater than that of $(\text{Cu}_2\text{S})\text{Cu}_2\text{S}$. The separated copper again reacts with uncombined ferrous sulphide (a reaction accelerated by rabbling the molten matte).



The cyclic process thus set up is only of short duration, as the small amount of free Fe is more readily eliminated by direct slagging than is the case with the free FeS, which sulphurizes the copper.

The Slagging of Nickel During the Poling of Copper to a "Set" Condition.—The operation of poling copper to a "set" condition, which follows the oxidizing fusion of high-copper matte, by rabbling and the skimming of the slag from the metal bath effects not only the removal of the absorbed SO_2 , but also the reduction of the cuprous oxide (Cu_2O) dissolved in copper, by the reducing action of the gases evolved in the metal bath. With overpoled copper, according to W. STAHL (*Metall. u. Erz*, 1917, vol. XIV, pp. 202-203), it happens that the period of poling to a "set" condition is more a reduction than a gas-removal period proper. The enhanced slagging of nickel during the "dense-poling" stage is attributed by the author to the decomposition of a combination of cuprous oxide and nickelous oxide originally held in solution. As a result of dense-poling there takes place at first a reduction of free cuprous

oxide, followed by reduction of some Cu_2O in combination with nickelous oxide, while the nickelous oxide itself remains unacted upon. As the nickelous oxide loses cuprous oxide, it becomes proportionately less soluble in the copper bath, until it finally liquates, combines with the acid radicals of silicates and ferrites, forming with the latter the tough, highly nickeliferous slag which is skimmed off. As a result of poling the copper to a tough-pitch condition (in which operation the layer of charcoal spread upon the metal bath assists the reduction) the remaining nickelous oxide of metal and slag is in turn reduced and the nickel retained in the metal bath.

Iron and Steel

Fatigue Failure of Boiler Plates.—E. B. WOLFF presented an exhaustive study of some obscure phenomena causing the cracking of boiler plates over the riveted seams before the Iron and Steel Institute (British), September, 1917. The cracks start as surface cracks of microscopical dimensions, each little crack being formed by itself, without reference to the position of its neighbors. Afterward, the cracks grow in length and depth and unite in longer ones, forming a peculiar stepped line. A polished and etched section through these cracks shows that the crystallites in the immediate neighborhood had not been deformed. The structure has also been found to be quite normal, no free cementite of segregations of importance having been found. All evidence pointed to a peculiar form of destruction of the surface layers of otherwise very plastic metal. Various tests showed that the material had not been sufficiently overstrained during fabrication to cause the trouble. The miniature cracks can be revealed and defective material discarded by etching the metal in 1:10 sulphuric acid for 24 hr. or more; before this treatment the cracks were covered by surface layers of oxides and were impossible of detection even after thoroughly scraping the plates. Microscopical sections through non-etched parts showed the cracks clearly. The only phenomena known where cracks of the kind described have been observed in plastic material is that known as "fatigue." Notwithstanding the severe conditions of the service, the number of alternations of stress is but few when compared to that number required to produce ordinary fatigue breaks. The author, then, by a careful study of the theory of stress in riveted joints, and the use of a special extensometer to show the distribution of stress in such joints, is able to show that the intensity of alternating stress at the parts which failed is well above the elastic limit, in which case, of course, only a comparatively few alternations are necessary to cause failure.

Composition of Rail Steel.—A test on the wear of street railway girder rails which extended over twenty-two years is reported by R. C. CRAM in the *Electric Railway Journal*, V. 51, p. 168. The Nassau Electric Railroad, Brooklyn, installed in 1895 several "soft" rails with carbon 0.28 per cent, and several "hard" rails containing what was then considered the high carbon of 0.59 per cent. The other metalloids were held as nearly equal as practicable in order that the effect of the carbon would be unmasked. Eight months later another line of rails "hard and tough" were added to the test—analyses of these rails being given in the table. At the present time the heads of all the rails seem to have worn

substantially the same amount, considering the narrow tread of the soft rail, and the shorter life of the hard and tough rail. Even so, corrosion of the rail base to such an extent as to prevent respiking has caused the replacement rather than wear on the head. The chief results are as follows:

	Soft Rails	Hard Rails	Hard and Tough
Height	7 3/16	8 35/32	8 25/32
Original head area.....	1.88	2.05	2.05
Amount worn, sq. in.....	0.56	0.58	0.56
Per cent worn	29	28	27
Carbon	0.28	0.59	0.57
Silicon	0.026	0.056	0.234
Phosphorus	0.106	0.097	0.050
Sulphur	0.066	0.059	0.078
Manganese	0.790	0.83	0.98
Elastic limit	45,730	62,500	53,160
Ultimate strength	75,860	118,100	121,380
Elongation in 8 in., per cent.	24.3	11.9	11.5
Reduction of area, per cent..	51.6	18.4	20.0
Vertical wear, inches.....	0.4063	0.3437	0.3125

Potash, Nitrogen and Grease from Sewage.—X. H. GOODENOUGH, chief engineer, and H. W. CLARK, chemist, of Massachusetts Department of Health, reporting to an investigating board on the possibility of recovering fertilizing material and grease from Boston sewage by the Miles process, say that at Bradford, Leeds, Huddersfield, Oldham and Norwich, England, processes are installed treating material of much higher value than the Boston sewage. At Leeds, progress made indicates that in time they expect to arrive at an artificial process which will operate without nuisance, and make sufficient by the sale of by-products at least to pay the full cost of the disposal. In Germany the various plants erected for this purpose had one after another been abandoned as failures. Taking into account that the far richer wool-scouring wastes at Lawrence, Mass., almost go begging for utilization, there seems no present justification for spending money for a large scale experimentation with the Miles process.

In 1910 the average output from the first and second bowls of all the wool scouring machines at Lawrence amounted to 211,000 gal. per day, containing 29,000 lb. of fatty matters, 14,000 lb. of potash and 2200 lb. of nitrogen; that is, 0.14, 0.07 and 0.01 lb. per gal., respectively. At the present time two companies are taking the richest wastes amounting to about 80,000 gal. per day from the first bowls from nearly all the mills at Lawrence, and are making some profit. One company recovers only fatty matters, these being worked into lanolin. Plants for the recovery of grease from wool waste are also in successful operation at three or four other points in Massachusetts. Compared with the wool-scouring waste, the richest sewage of Boston contains 0.0006 lb. of fatty matter per gal., a very small amount of organic nitrogen, and practically no potash, the utilization of which constitutes a very difficult problem.

Analysis of Sulphur Burner Gases.—A paper on this subject was presented by F. M. WILLIAMS of Watertown, N. Y., at the recent meeting of the Technical Association of the Pulp and Paper Industry in New York. In the efficient operation of the sulphite mill, one of the most important considerations is the constant knowledge of the strength of the burner gas, SO_2 , being produced. In the author's observation, the greatest variation occurs in the strength of the gas in different mills, as well as in the same mill at different periods.

He has found some mills struggling along with weak acid troubles, when an analysis of the burner gas showed that they were trying to make acid with only 60 per cent SO_2 burner gas. The proper regulation of the burners by merely the appearance of the flame is much the same as trying to run a steam boiler at a definite pressure, without a steam gage.

There are two general methods of determining SO_2 in burner gases. First, by means of an instrument of the Reinsch type, in which a measured volume of gas is drawn through a standard iodine solution, which absorbs the SO_2 . The principal objections to this method are that a single passage of the gas through one or two, or sometimes three, absorption bottles, does not in all cases absorb all of the SO_2 gas, and it is never possible to check the completeness of the absorption. Further, in the measurement of the complete volume of gas taken, we are dependent upon the volume of water which has passed out of the aspirator bottle, and it is necessary to apply various corrections for temperature, reduced pressure, and we always have the constant danger of error through leakage. A much more satisfactory method of analysis is the direct method, in which a measured volume of the sample is passed through a caustic potash solution in a suitable absorption pipette, after which the residue is returned to the original burette for measurement, and the operation repeated until a constant volume is obtained, the difference being SO_2 gas absorbed by the potash solution. This operation may be performed in various types of Orsat instruments.

A number of years of professional experience in sulphite mill work convinced the author of the need of a special modification of the Orsat particularly adapted to the analysis of sulphur burner gases. He has, consequently, developed a modified Orsat, known as the Williams Improved Gas Apparatus.

This instrument not only gives the percentage of SO_2 in the burner gas, but by means of the second or middle absorption tube a direct determination of the excess of air or oxygen is obtained. This is very important in burner regulation, and also in the determination of air leaks in the acid system.

In order to make the instrument equally available for the analysis of flue gases in boiler-room practice, a third or carbon monoxide tube is added, which makes it possible to determine quickly CO , oxygen and carbon monoxide.

In the first place, making acid with a 6 per cent gas, as against a 17 per cent or 18 per cent gas, requires about three times the length of time for makeup in a milk of lime system, with constant loss of production and a resulting acid of inferior quality. The same principle holds true in making acid in the tower system. Too weak a gas does not attack the stone readily, and it is impossible to obtain an acid of the desired quality.

On the other hand, there are troubles arising from too hot a fire, which would give a gas of sufficient richness, but will volatilize sulphur. While it is theoretically possible to obtain a gas by burning sulphur and air, of about 21 per cent SO_2 , whenever this is reached in actual practice it has been the writer's observation that there has always been a volatilization of sulphur, and it would appear that a gas of from 17 to 18 per cent SO_2 is about the maximum practical working strength.

Recent Metallurgical and Chemical Patents

Electric Furnaces

Method of Starting Furnaces.—W. K. BOOTH of Chicago, Ill., patents a method of easily starting arc furnaces containing wall or hearth contacts, embedded in the lining of the furnace, whose walls, while conductive when hot, are virtually non-conductors in the cold. In starting up a cold furnace, therefore, the main electrodes rest upon the charge, and the common return in the hearth, being in effect insulated from the other electrodes, is replaced by an auxiliary electrode lowered through the roof to contact with the charge. This auxiliary electrode is manually operated, is electrically connected to the lines leading to the hearth contact, and remains in operation until the interior of the furnace becomes hot enough to allow the latter to function when the auxiliary electrode is completely withdrawn. (1,244,415; Oct. 23, 1917.)

Cooled Bottom Electrode.—MARTIN SPERLING of Essen-on-the-Ruhr, Germany (assigned to Krupps' A.-G.), patents a special design for bottom electrodes. Former construction calls for a hollow cone shape, cooled inside by a water stream. In a number of cases disastrous explosions have occurred in such electrodes due to the occasional insulation of several of the bottom electrodes from the smelting bath by pieces of clinker or refractory. The other electrodes then carry the entire load, which is in excess of the safe current density, bringing into incandescence the lowermost annular portion of the electrodes. The cooling water then gasifies with explosive violence. Sperling's construction is of low carbon iron and is illustrated in Fig. 1; it con-

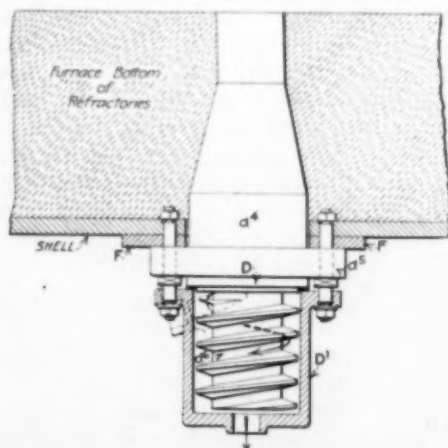


FIG. 1. COOLED BOTTOM ELECTRODE

sists of a solid upper part d' , a current collecting collar d' placed above a cooling cap D' and threaded electrode extension d' , around which the water circulates. Current is thus led in through bronze plates F above the cooling water and into a solid conductor of large cross section and consequent large current capacity. Overheating is thus minimized, and contact of water and incandescent metal is impossible. (1,234,947; July 31, 1917.)

Water Cooled Furnace Linings.—E. F. PRICE of Port Chester, N. Y., patents a method of protecting electric

furnace linings from rapid destruction by air and moisture entering the fissures opened by temperature changes. Ingress of cooling fluid is prevented by laying 30-gage iron plates shingle-wise between the metal furnace bindings and the refractory lining. (1,239,214; Sept. 4, 1917.)

Low-Temperature Furnace.—I. R. VALENTINE of Schenectady, N. Y. (assigned to General Electric Co.), patents the furnace shown in cross-section in Fig. 2

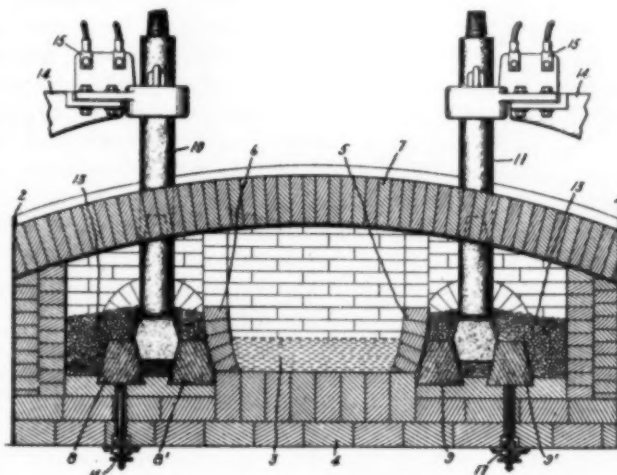


FIG. 2. LOW-TEMPERATURE FURNACE

for heating charges at relatively low temperatures in the hearth formed of carborundum brick (5 and 6). On opposite sides of the hearth are two continuous conducting prisms 8, 8', 9 and 9', supporting at intervals small graphite blocks located directly under the electrodes 10, 10' and 11, 11'. (10' and 11' are directly behind 10 and 11 and therefore not shown.) In operation current enters through electrode 11, arcs to the block below, is carried through 9 and 9' to another block, whence it arcs across to the second electrode 11'; thence back and forth through as many successive electrodes as is necessary by reason of the furnace construction. The arc is smothered by granular carbon. The central hearth is heated by conduction through the side walls and by reflection of heat rays from the arc to the roof. The use of arcs in series is flexible, easily controlled, and may use low amperage currents of high voltage. (1,242,275; Oct. 9, 1917.)

Brass Melting Furnace.—WOOLSEY MCA. JOHNSON of Hartford, Conn., patents a reverberatory melting furnace heated by a conducting grid, forming the roof of the hearth. The grid is composed of square carbon rods, acting as rafters, resting in niches in the side walls. Leading from rafter to rafter, and from the electrode blocks at either end, are short carbon bricks acting as purlins, loosely placed on the rafters. The whole may then be covered with as deep a layer of granular coke as is desirable. Some inert gas may be forced downward through the resistor toward the surface of the melt; this acts as a positive conveyor of heat, and will localize the current path near the bottom of the resistor bed by cooling the upper layers. A built-in stirrer to properly mix the melt is another feature of the invention. (1,243,416; Oct. 16, 1917.)

Hearth for Kjellin Furnace.—JAKOB FUNCK of Charlottenburg, Germany, has observed that the ordinary method of forming the trough-shaped hearth of

the Kjellin furnace, viz.: by ramming the magnesite in plastic condition around a templet, which is then removed and the mass baked by means of heating rings suitably placed in the hearth, is unsatisfactory owing to deformation suffered by the lining during the heating, and the binder at the surface is burned rather than coked, thus producing a pulverulent facing. He therefore proposes a massive iron template, which is left in place after ramming and which is electrically continuous, so that it is used as a heating element for drying and baking the new hearth. The latter is thus supported adequately during heating, and is entirely protected from the air up to the point where the template melts. The metal of the form then becomes the first charge. In case contact between hot metal and fresh lining is undesirable, the two are separated by asbestos board or other neutral refractory. (1,226,764, May 22, 1918.)

Current Control.—J. A. SEEDE of Schenectady, N. Y. (assigned to General Electric Company), patents a method of current control to electric furnaces, whereby reactance is placed in the main circuit without interrupting the current. He provides reactance devices or transformers 12 and 13 (Fig. 3) where the main fur-

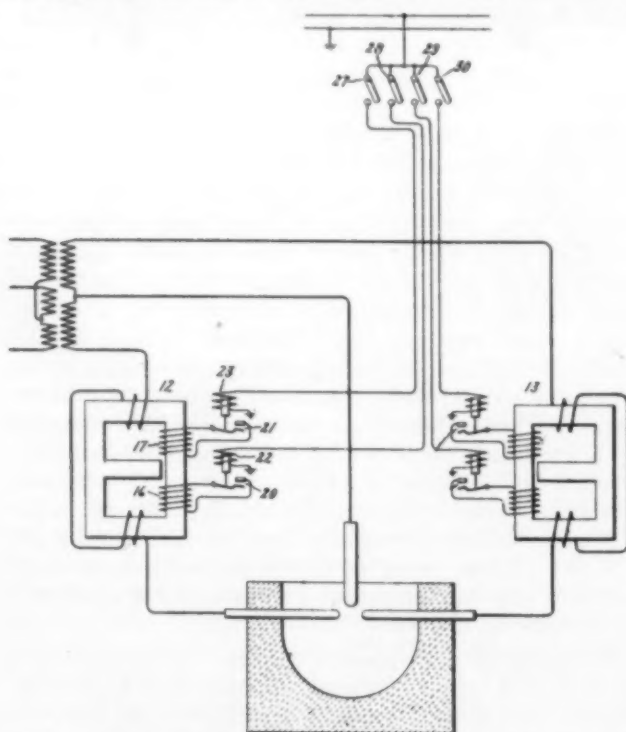


FIG. 3. WIRING DIAGRAM WITH REACTANCE IN CIRCUIT

nace supply lines form a primary winding 14 of a few turns. Secondary windings 16 and 17 may be short-circuited at 20 to 21 by solenoids 22 and 23 remotely controlled. By closing switches 27 to 30, any number of the secondary coils will be short-circuited, thus reducing the reactance in the supply mains. The larger the comparative number of turns in the secondary winding the smaller the current in that circuit and the more readily interrupted. The correspondingly increasing voltage will not be inconvenient, since the arc voltage is usually low, of the order of 100 volts, while the amperage may be many thousand. The arrangement is said to be inexpensive and reliable. (1,242,250; Oct. 9, 1917).

Miscellaneous

Increasing Capacity of Sulphuric Acid Plants.—A method for increasing the density of the sulphur dioxide entering into the manufacture of sulphuric acid is patented by MARION L. HANAHAN of Dothan, Ala. The pyrites burners used are of the ordinary construction and the gas chamber in the top is connected by a flue to a dust chamber. The flue enters the dust chamber at a point about midway between the top and bottom, and the dust chamber has an outlet near its upper end which opens into a flue. The niter oven is located between the dust chamber and pyrites burners and below the flue connecting these.

A cast iron shallow pan or container is supported on the floor near the bottom of the dust chamber. This pan is designed to hold commercial sulphur when the same becomes molten and is burning. The commercial sulphur is charged in the pan through a door cut in the side of the dust chamber opposite the sulphur container. An air pipe extends through the wall of the dust chamber and over the pan and has one or more openings to supply air or oxygen under pressure in close proximity to the sulphur in the pan. This oxygen or air is necessary to support the combustion of the sulphur in the pan to provide the sulphur dioxide. The heat necessary for melting and burning the sulphur in the pan is derived from the heat of the gases entering the dust chamber from the pyrites roaster. The sulphur dioxide produced by the burning of the sulphur in the pan in the presence of air supplied by the pipe rises and commingles with the sulphur dioxide entering the dust chamber from the pyrites roaster and the excess sodium nitrate carried by the latter gas is sufficient for the additional sulphur dioxide produced by the burning sulphur in the pan. (1,253,238, Jan. 15, 1918.)

Preparation of Alums from Clay.—LOUIS L. JACKSON of New York, N. Y., proposes to treat clay in an uncalcined condition and heat it with niter cake at a temperature of at least 150 deg. C., but at a temperature below that needed to calcine the clay and below that needed to decompose the niter cake alone. Silica, soda alum and sodium sulphate are formed, the silica being in an insoluble condition, whereas in the common process a considerable quantity of the silica is soluble. The soda alum and sodium sulphate are dissolved out with water and separated by crystallization.

Ammonium sulphate or potassium sulphate may be added in the proportion of one molecule of the sulphate to each molecule of alum, and the more sparingly soluble ammonia alum or potash alum may be obtained. While the temperature must exceed 150 deg. C., it is uneconomical to employ a temperature much above 400 deg. C., but it would be possible to get good decomposition at any temperature above 400 deg., at which all the products used and made are stable if heated by themselves. A temperature of about 350 deg. C. is preferred. (1,254,229, Jan. 22, 1918.)

Decomposing Magnesium Silicates.—LOUIS L. JACKSON of New York, N. Y., proposes to render the natural silicates, such as talc, soapstone, chrysolite, etc., soluble in acids by heating at a relatively low temperature with a large excess of caustic alkali. They are decomposed into an alkaline silicate and a silicate of magnesium which is readily soluble in acids, even in very dilute acids (for example, 1 per cent sulphuric acid), or even

diluted organic acids like acetic acid. Using twice the theoretical quantity of caustic alkali and heating even as high as 600 deg. C. for two hours, only about one-half of the soapstone is decomposed; while by using four times the theoretical amount, almost complete decomposition may be obtained in the same time at 350 deg. C., or even at a lower temperature. As the caustic alkali is recovered and used over again, there is no objection to using this large excess. (1,254,230, Jan. 22, 1918.)

Tanning Compound.—A sulphuric acid tanning compound is patented by OTTO SCHMIDT and ARTHUR ANDRES of Ludwigshafen-on-the-Rhine, Germany (assigned to Badische, Anilin and Soda Fabrik). An example of the preparation of this compound is given as follows:

"Shake together for some time, 94 parts of phenol, 22 parts of paraldehyde, and a small quantity of concentrated sulphuric acid. As reaction takes place heat is evolved, and care should be taken that the temperature does not rise above 90 deg. C.

"When the reaction is complete, add 100 parts of 97 per cent sulphuric acid and stir, while warming gently, until the reaction product is soluble in water. Take a concentrated solution of this compound, partially neutralize it with caustic soda solution and then dilute it with water until a solution of 2½ deg. Baumé is obtained. Then add ten grams of common salt to each liter of this solution and employ it for tanning. Leather is obtained which, after being treated with fat, possesses a good resistance to tearing. (1,254,364, Jan. 22, 1918.)

Potash

Potash from Tobacco Plants.—WM. H. KENNEDY and GILBERT E. BAILEY of Los Angeles, Cal., patent a process of extracting potash from the stems, ribs and leaves of the tobacco plant not ordinarily used in the manufacture of cigars, etc. The tobacco is percolated with denatured alcohol and the extracts withdrawn. The gums and resins are distilled from the residue and the residue is then roasted in the presence of charcoal to form carbonates, which are then leached with hot water to extract the potassium carbonate which is subsequently recovered. (1,253,497, Jan. 15, 1918.)

Potash from Feldspar.—EDWARD L. ANDERSON of Pittsburgh, Pa., patents an electrolytic process of obtaining potash from feldspar. Feldspar or the like material may be decomposed by electrochemical means with a relatively small amount of electrical energy by first mixing an insoluble conductive material, such as carbon or a carbon compound, so as to make the mixture a conductor of electricity. This mixture is packed in the anode compartment of a cell having a porous partition between anode and cathode compartments. The mixture is saturated with water containing five or ten per cent of hydrofluosilicic acid. The cathode compartment is filled with water. The action of the electric current is to decompose the feldspar, producing potassium hydroxide in the cathode compartment and a mixture of aluminum oxide and silica in the anode compartment. (1,253,560, Jan. 15, 1918.)

Potash from Glauconite (Green Sand).—FREDERICK TSCHIRNER of Newark, N. J., patents a process of extracting potash from green sand, which is briefly as follows: One hundred parts by weight of green sand

marl (glauconite) are mixed with fifty parts of lime sand (gray calcareous marl) and thirty parts of calcium chloride. This mixture is submitted to a roasting temperature with access of air to a temperature of about 800 to 820 deg. C., care being taken to avoid a heat sufficient to form clinkers. The first result of this roasting is to dehydrate the green sand and convert the calcium carbonate largely into calcium oxide. In the presence of the calcium oxide so formed, the calcium chloride acts on the dehydrated green sand, whose ferrous salts have been converted into the ferric condition by oxidation and produces potassium chloride. The lime also reacts with any soluble ferric salts, *e. g.* chloride to produce ferric oxide and calcium chloride. This mixture after roasting can then be leached either with or without powdering and the potassium chloride can then be extracted. (1,254,450-1, Jan. 22, 1918.)

Separation of Potassium and Sodium Salts.—JOHN R. MACMILLAN of Niagara Falls, N. Y., patents a process of recovering high grade potash salts, which is assigned to the Niagara Alkali Co. He employs the differential solubilities of the carbonates and bicarbonates to give a separation in a single operation. The solution (with or without preliminary separation of normal sodium carbonate by cooling to 5 deg. C. to 0 deg. C.) is treated with carbon dioxide gas at a temperature of 20 to 30 deg. C. This converts the alkalies into bicarbonate and the sodium is precipitated. The solution is then cooled to 1 deg. to 5 deg. C., when crystals of pure potassium bicarbonate will be formed. These crystals when dried, with ordinary washing, contain, ordinarily, not over 2 to 4 per cent sodium bicarbonate and under 1 per cent sulphates and chlorides even in the case of solutions containing much sulphate and chloride. (1,254,521, Jan. 22, 1918.)

Potash from Glauconite (Green Sand).—WALTER GLAESER of Fullerton, Pa., patents a process of treating glauconite, which is assigned to the Potash Extraction Corp. of New York. The finely ground green sand is mixed with about sixty per cent of its own weight of calcium chloride and 5 per cent of coke, and the mixture heated to 270 deg. C., to drive off the moisture. Air is excluded in this operation. The mixture is next heated to 800 deg. C., in a non-oxidizing or reducing atmosphere. In this step potassium chloride and a silicate of iron and calcium are formed. (1,254,676-7, Jan. 29, 1918.)

Potash from Feldspar.—A process of producing alkali carbonates, containing small amounts of alkali hydrates, from alkali rocks is patented by HARRY W. CHARLTON of New York. In treating feldspar from 3 to 6 parts of same is digested with 7 to 2 parts of a mixture of lime and calcium carbonate in 44 to 26 parts of water at pressure above 200 lb. and corresponding temperatures. Most of the potash is thereby extracted. The residue is white and is used in making brick. (1,256,295, Feb. 12, 1918.)

Electric Furnaces in Canada.—Discussing the subject of electric smelting in an address at the recent annual meeting at the Commission of Conservation, Sir Clifford Sifton said that there are, at the present time in Canada, 32 Heroult electric furnaces and 22 of other types—54 furnaces in all, with a capacity of 173,000 tons of iron and steel, 50,000 tons of ferro-silicon, and 8000 tons of other ferroalloys per annum.

A New Method of Microscope Illumination

BY ALEXANDER SILVERMAN*

FEELING the need for an illuminator which would furnish diffused light for examination of opaque objects and which could be lowered into hollow objects, the writer has devised the following microscope accessory:

A circular tube containing a tungsten filament is separably attached to a ringlike holder (Fig. 1),

about. The lamp possesses the additional advantage that it shows details not visible when vertical illuminators are used. Fig. 3 shows a specimen photographed with a vertical illuminator; Fig. 4 the same photographed with the new illuminator.

Examination of the photomicrographs shows that those portions which are dark by vertical illumination are light in the new prints. This possesses the advantage that for lantern slides one can use the negative directly for comparison with earlier work done with

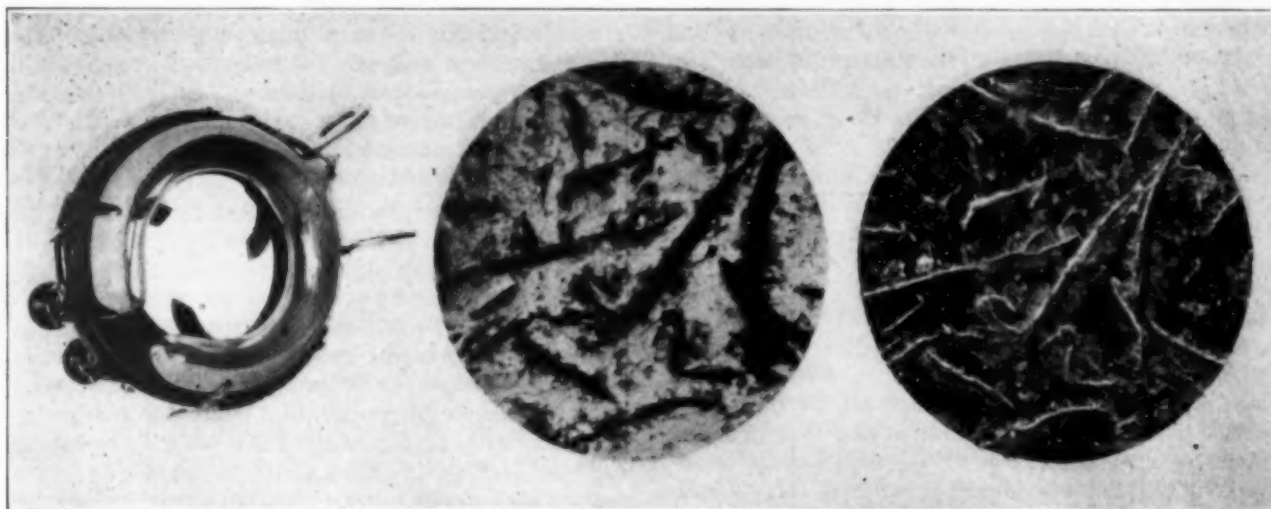


FIG. 1

FIG. 3

FIG. 4

which by means of three centrally protruding fingers, controlled by springs, is clamped to the microscope objective (Fig. 2). The holder may be raised or lowered to modify the quality and intensity of the light. The lamp is made of colorless or blue (day-light) glass having a white reflector on the upper portion, and in models in use requires 0.7 ampere and 6 volts. It can be connected to a 110-volt light-

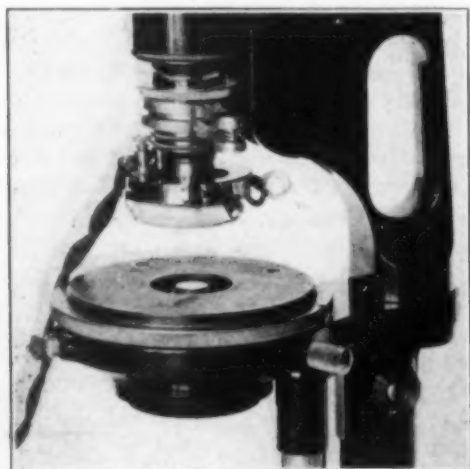


FIG. 2

ing circuit with a resistance in series, or to a storage battery system.

The new illuminator¹ possesses the advantage that it travels with the microscope tube and is always in position, even though the microscope may be moved

vertical illuminators. The definition of the image obtainable by the new process should result in additional important developments in the field of metallography. It has been employed successfully with a 60-mm. objective for photographic purposes where other forms of illuminators were unsatisfactory and serves well for powers up to 4 mm.

By varying the resistance one can obtain different light intensities for special purposes. By adjusting the position of the lamp almost any desired contrast is possible. The light is steady, so clear images are obtainable. Any one who has used an arc lamp realizes the difficulty experienced in adjusting the light in photomicrography.

The illuminator is so constructed that it can be used with any type of nosepiece or objective, including the new short type. It is only necessary to clamp it to the objective by means of the spring clamp.

The writer's attention has been called to the fact that in vertical illumination the eye is strained by rays passing up and down through the inclined disk and because the observer has to look through this additional obstruction. The light spot due to the source of illumination also causes strain. In the new process the light source surrounds the objective and a soft light travels through the tube in one direction.

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*Professor of General and Physical Chemistry University of Pittsburgh.

¹Patents applied for.

Muscle Shoals Dam Authorized.—An order has been signed by President Wilson authorizing the construction of a water-power dam at Muscle Shoals which will form a part of the government's nitrogen fixation plants and will cost \$50,000,000. The Alabama Power Co. gave the government the dam site without cost.

Improvement in Sintering Blast Furnace Flue-Dust

A NEW and improved design of the Dwight and Lloyd sintering machine, which is shown in the accompanying photographs, was recently completed for the Carnegie Steel Company, New Castle, Pa., and is to be used there for sintering blast-furnace flue-dust. This new machine has an active grate surface 42 in. wide and 57 ft. 4 in. long and a sintering capacity $2\frac{1}{4}$ times that of the present standard Dwight and Lloyd machine.

This new large sintering machine contains a number of important improvements which are the result of the experience gained by the American Ore Reclamation Company in the operation of the many standard Dwight and Lloyd sintering machines which have been installed in plants in the last six years.

The standard Dwight and Lloyd machine heretofore used has an active grate surface 42 in. wide and 25 ft. 6 in. long and the lower strand of pallets rolls by gravity along an inclined track back to the driving sprocket wheels. The much greater length of the new machine makes the use of a gravity return undesirable and the lower strand of pallets is, therefore, positively driven along the lower track by sprocket wheels at the discharge end. These discharge-end sprocket wheels are driven in synchronism with the driving-end sprocket wheels as shown in Fig. 1. This synchronous drive insures that the empty pallets are returned to the driving sprocket wheels at the same rate of speed as that of the pallets on the upper strand.

On this new large machine, sliding friction between the pallets and the wind-box tops is eliminated by carrying the weight of the loaded pallets on wheels running on rails. The pallet wheels are fitted with renewable Shelby steel bushings and have large oil spaces that carry a month's supply of grease. The sprocket-wheel teeth drive against tooth surfaces cast in the frame of the pallet and not against the pallet wheels, thus allowing the pallet wheels to properly perform their rolling function around the curved tracks at the drive end.

All of the gears and the sprocket-wheel teeth on the new machine are made of steel castings. All gears and

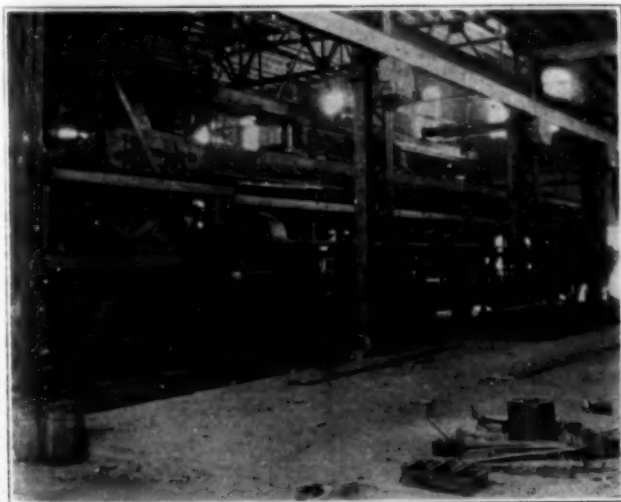


FIG. 1. GENERAL VIEW—PALLETs LOADED WITH PIG IRON FOR TESTING PURPOSES

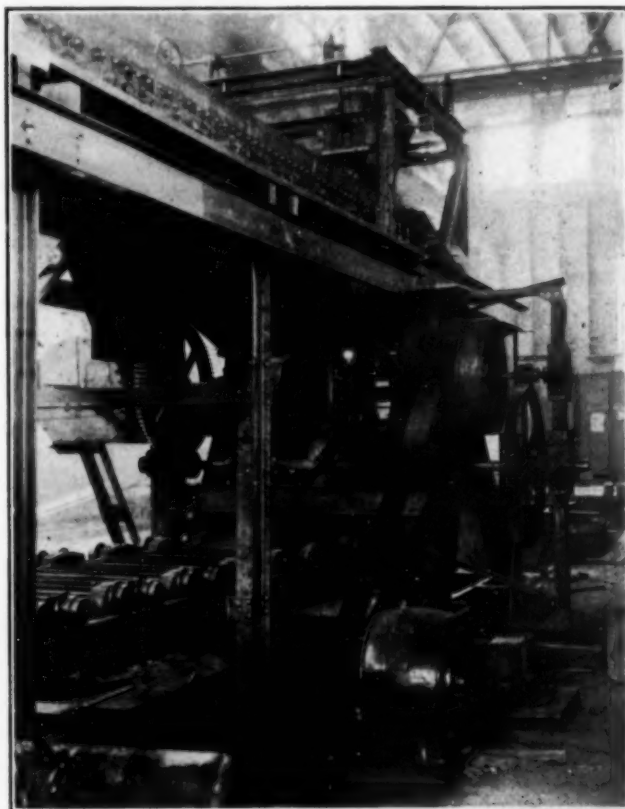


FIG. 2. DRIVE END

the shaft couplings are wholly enclosed in heavy sheet-steel housings. The sprocket-wheel teeth are removable and are machined in jigs so that they are interchangeable, and when worn may be replaced without tearing down the larger members of the drive. The driving pulley is fitted with a cast-iron break-pin to prevent accidental injury to the driving mechanism.

An important feature of the new machine is the use of seal bars on the pallets which automatically maintain air-tight joints between the pallets and the tops of the wind boxes. These seal bars are made very light, and by their own weight bear on the finished surfaces of the wind-box tops and also fit against the finished sides of the pallet slots in which the bars are hung.

The first one of the new machines was thoroughly tested under full-load conditions, which were obtained by loading the upper strand of pallets with 20 tons of pig iron, as shown in the photograph. In all of the tests the machine ran with a notable degree of smoothness and the seal bars made a tight joint. The horsepower readings taken during the tests show that the various improvements have been fully effective in reducing the driving load.

The fully loaded machine as set up for the test required $12\frac{3}{4}$ hp.

Based on the performance of the smaller machines now in service, the capacity of the new large machine, when sintering various materials, is estimated to be as follows:

	<i>Tons Sinter per 24 hr.</i>
Flue-dust	300 to 350
Pyrites cinder.....	375 to 450
Magnetic concentrates.....	450 to 550

Heavy Hauling with a Tractor

Some recent interesting applications of the tractor in industrial plants are shown in the accompanying illustrations. They suggest many other possible similar uses. Fig. 1 shows a tractor on transfer-buggy



FIG. 1. TRANSFER BUGGY WORK. LAKE ERIE IRON CO., CLEVELAND



FIG. 2. ENGINE BASE CASTING ON WAY FROM FOUNDRY TO MACHINE SHOP. WEIGHT ABOUT 2500 LB.

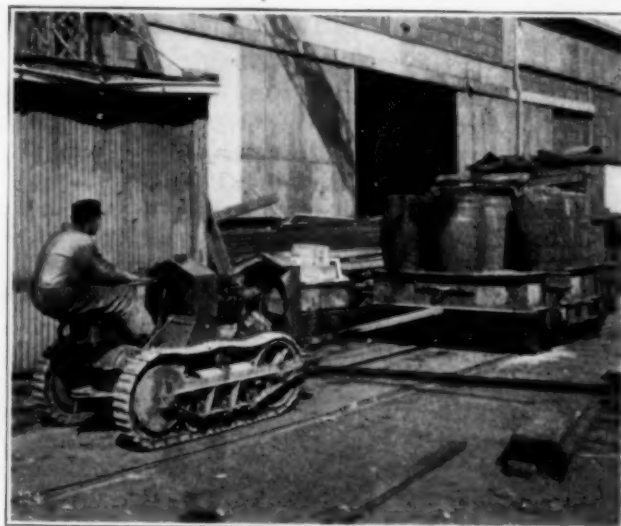


FIG. 3. 20,000 LB. STEEL FILINGS AND TURNINGS; TRACTOR ON STEEL FLOOR PLATES PUSHING TRANSFER BUGGY. VAN DORN IRON MILLS, CLEVELAND

work at the Lake Erie Iron Company, Cleveland, Ohio. Fig. 2 shows an engine base casting weighing 2500 lb. on the way from the foundry to the machine shop. Fig. 3 shows 20,000 lb. of steel filings and turnings being moved by the tractor, which is on steel floor plates at the Van Dorn Iron Works, Cleveland, Ohio.

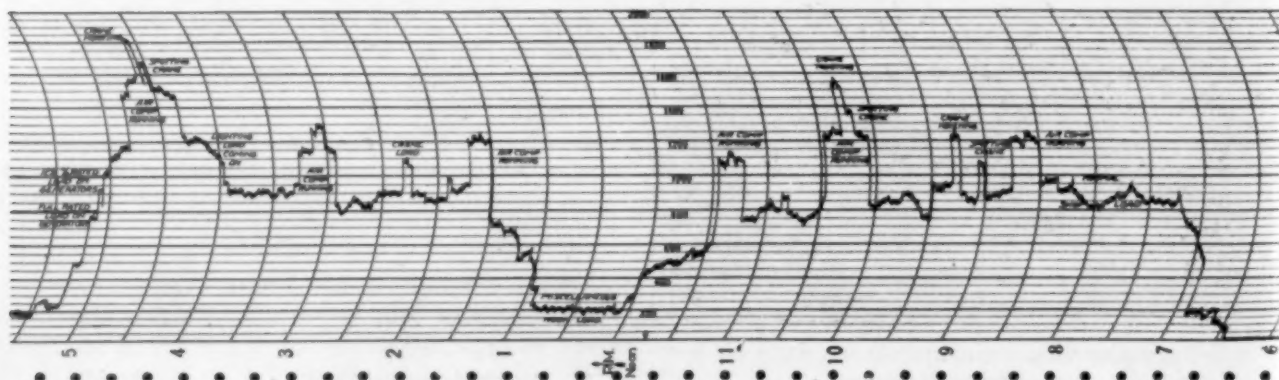
The tractors were made by the Cleveland Tractor Company, Cleveland, Ohio.

Value of Graphic Records in Management

The accompanying record is a representative piece from an instrument installed in a manufacturing plant by the Esterline Co. of Indianapolis. It shows the value of graphic records.

The company generates its own electricity for light and power. The steady plant load has grown until it is a full and efficient load for the boilers and the two generating sets installed. In addition they have several pieces of heavy equipment, operated only occasionally, which throw an excessive and damaging overload on the power plant. Hence the plans for a new addition to the plant.

The record from the graphic instrument, picturing the output of the plant at all hours of the day, showed that while the peak loads thrown on the plant



were greatly in excess of its capacity, they are of short duration, and measured in kilowatt-hours do not call for sufficient energy to warrant the installation of additional equipment. Actual figures showed that the company would make money by carrying the steady load on their power plant, and purchasing the peaks from the local power company.

Personal

Mr. H. A. BRASSERT, who has been connected with the U. S. Steel Corporation since its organization, has resigned his position as assistant general superintendent of the Illinois Steel Co. at South Chicago in order to devote himself to his personal interests. As vice-president of the Miami Metals Co. and subsidiary companies he will have charge of their operations in the production of ferromanganese. Mr. Brassert will also act as consulting engineer for Freyn and Company, engineers and contractors. He will associate himself with Messrs. Francis H. Hardy and Chester D. Tripp, in the firm of Brassert, Hardy & Tripp, to act in a consulting and advisory capacity on commercial and operating problems in the iron and steel and affiliated industries. Mr. Brassert will remain in Chicago, with offices in the Peoples Gas Building.

Mr. H. P. CURTISS has been appointed New England representative for the Clarage Fan Company, Kalamazoo, Mich., with offices at 120 Milk Street, Boston.

Dr. W. F. FARAGHER has resigned his position as research chemist for the Alden-Speare's Sons Co. to become Senior Fellow at the Mellon Institute in Pittsburgh. He will work on crude petroleum.

Mr. LEON O. HART has been elected treasurer and a director of the Driver-Harris Co., Harrison, N. J. Mr. Hart has been with the company since 1908 and since March, 1917, has been assistant treasurer.

Mr. HENRY C. HOWARD, JR., treasurer and chief chemist, Charles A. Newhall Co., Inc., Seattle, Wash., has joined the 30th Engineers and is now stationed at Fort Myer, Va. Mr. Howard has specialized in electrochemistry and had recently developed a process for the manufacturing of potassium per-chlorate, the potassium salts being derived from kelp. The process is now being operated on a commercial scale in Seattle.

Dr. I. F. LAUCKS, formerly of Falkenburg & Laucks (dissolved), has opened his new laboratory in Seattle. This laboratory will specialize in the examination of materials of commerce originating in this territory and passing through the port of Puget Sound. The commerce of this port has increased so rapidly in the last few years as to justify the establishment of such a laboratory. A fully equipped metallurgical laboratory is also maintained.

Recent changes have been made in the staff of the Ohio & Colorado Smelting & Refining Co., at Salida, Colo., as follows: E. H. LAWS has resigned as superintendent; A. T. THOMPSON has been appointed superintendent; E. J. BRUDERLIN, assistant superintendent; W. H. NANCE, superintendent of roasting department; J. H. FINGER, chief chemist.

Dr. E. H. LESLIE has resigned from his position as chief chemist of the General Petroleum Corporation of Los Angeles and has assumed new duties as technical adviser to the sales department of the U. S. Industrial Alcohol Company and the U. S. Industrial Chemical Company. He will be located in their main offices at 27 William Street, New York City.

Mr. LOYALL A. OSBORNE of New York, vice-president of the Westinghouse Electric & Manufacturing Company and Chairman of the Executive Committee of the National Industrial Conference Board, has been appointed, by the Secretary of Labor, a member of a committee on industrial peace during the war.

This committee, which consists of five representatives of employers, five labor leaders, and two public men, will pro-

vide a definite labor program in order that there may be industrial peace during the war, thus preventing interruption of industrial production vital to the war.

The Worthington Pump and Machinery Corporation has made a number of appointments in its staff, effective March 1, as follows: JAMES E. SAGUE, vice-president, in charge of engineering and manufacturing; LEON P. FEUSTMAN, vice-president, in charge of general commercial affairs, including contracts, prices, purchases, traffic, etc.; FRANK H. JONES, vice-president, in charge of sales; WILLIAM GOODMAN, assistant to vice-president; WILLIAM SCHWANHAUSER, chief engineer; EDWARD T. FISHWICK, general sales manager; CHARLES E. WILSON, assistant general sales manager. The offices of the above will be at 115 Broadway, New York. NEIL C. LAMONT, works manager, Laidlaw Works, with offices at the works, Elmwood Place, Cincinnati, Ohio.

Mr. E. GYBBON SPILSBURY left New York on Feb. 24 for Cuba and expects to be absent about six weeks. The offices of the E. G. Spilsbury Engineering Co. have been moved from 45 Broadway to 29 Broadway, New York.

Mr. POPE YEATMAN has been placed in charge of the non-ferrous metals department of the Raw Materials Division of the War Industries Board, succeeding Eugene Meyer, Jr. Mr. Meyer remains a member of the Raw Materials Division, but for the present is engaged on special work for the Secretary of War.

Book Reviews

STANDARD TABLE OF ELECTROCHEMICAL EQUIVALENTS AND THEIR DERIVATIVES, WITH EXPLANATORY TEXT. By Carl Hering and F. H. Getman. Duodecimo. 130 pages. Leather binding. Price, \$2.00. New York: D. Van Nostrand Company.

The tables are based on 96,494 coulombs as the value of the Faraday, and on the atomic weight of oxygen 16. They give for each element, for its usual valence, or for its more usual valences if it has several, the milligrams per coulomb, coulombs per milligram, grams per ampere-hour, ampere-hours per gram, pounds per 1000 ampere-hours, and ampere-hours per pound. For elements which frequently change their valence in electrolysis, these data are also given for a change of valence of unity. These tables are very carefully calculated, and the figures are probably the most reliable now in print. Dr. J. W. Richards contributes a supplementary tabulation of the valences of the elements in their various combinations, as bases and acids; the values given are the practical or apparent valences, irrespective of any interpretation involving structural formulas. The term "non-valent" is used for elements forming no known combinations; valence zero is reserved for all free elements, not in combination, as is logically required by Faraday's Law.

The remainder of Part I deals with illustrations of calculations based on the electrochemical equivalents. They are carefully explained, and will teach the reader much fundamental electrochemistry. The chemical terms are here at times used loosely (e.g., the atomic weight of SO₂ is spoken of), and the chemistry involved in explaining the electrolysis of 2 Cu Cl to form Cu and Cu Cl₂ is decidedly vague: it is certainly wrong even to suggest that one of the two molecules of Cu Cl is changed to Cu Cl₂ at each electrode.

Part II consists of 35 pages of explanation of electrolysis, and a short statement of the electronic theory. Some of the statements in this part are too general (e.g., "Fused salts form practically the only exception to the rule that pure chemical compounds are non-conductors of electricity"—this ignores the conducting oxides, sulphides, etc., and all the pure materials conducting at high temperature, such as MgO, etc.). The term "electrolyte" is used very vaguely, sometimes for the undissolved solid salt, sometimes for the salt in solution, sometimes (correctly) for the solution, and once for the solvent. Greater precision in this regard is certainly desirable.

Two appendices, written by Dr. Hering, deal with "Valence" and "Elementary Principles of Chemical Reactions and Calculations." The handling of + and - valences at

anode and cathode is carefully worked out, and is worthy of the attention of chemical philosophers; the system should be adopted, for it is clear and logical. Electrolytically, the elements as they are set free from combination by the reducing effect of the current at the cathode or its adducing effect at the anode, must be regarded as having their valences reduced or adduced to zero, in each case. This conclusion is a categorical imperative. The authors deserve our thanks for the time and effort they have put on what is certainly a useful book.

* * *

REPORT OF THE ROYAL ONTARIO NICKEL COMMISSION. With Appendix. Octavo (15 x 24 cm.), xlviii + 646 + 218 (appendix) pages. Printed by order of the Legislative Assembly of Ontario. Toronto, 1917.

The commissioners producing this report were G. T. Holloway of the Royal College of Science, London, and vice-president of the Institution of Mining and Metallurgy; W. G. Miller, provincial geologist of Ontario; McGregor Young of Toronto, and T. W. Gibson, Deputy Minister of Mines, Toronto. We name these gentlemen because they have done a splendid piece of work and deserve personally the thanks of the metallurgical fraternity as well as the gratitude of the Canadian government.

The first 48 pages are a summary and conclusions. The two principal questions to be determined were: (1) Can nickel be economically refined in Ontario? (2) Are the nickel deposits of Ontario of such a character that this Province can compete successfully as a nickel producer with any other country? The commissioners had no hesitation in answering both these questions in the affirmative. Their studies, however, on which these conclusions were based, and which are set forth in *extenso* in their report, embraced (a) The occurrence, deposit, supply, mining, products, by-products and alloys of nickel in Ontario and elsewhere, together with the present, probable and possible uses thereof. (b) The smelting, refining, manufacture and treatment of nickel, its ores, products, by-products and alloys, in Ontario and elsewhere. (c) The demand and market for nickel, its ores and products, by-products and alloys. (d) The probable development and requirements of the nickel and allied industries in Ontario. (e) Suggestions upon a just system of taxation of nickel lands, ores, products and industries in Ontario.

A further review of the book is unnecessary: we need only to state that the commissioners have actually fulfilled this amazing program, and have done it handsomely. All the previous treatises on nickel put together do not contain as much valuable information concerning this subject. It is absolutely comprehensive and complete. (For instance, 56 pages of Bibliography of Nickel.) We congratulate them sincerely on their fine work.

As a practical question it remains to state how the report is distributed.

when the worst conditions obtained. In various districts there has been a shortage of beehive coke owing to insufficient movement, and this influence has been most pronounced in the case of Connellsville. In February Connellsville coke shipments rose to a rate of nearly 300,000 net tons a week, but the requirements of the furnaces regularly tributary to the region are fully 375,000 tons a week. On the assumption that pig iron production is 10,000,000 tons a year under capacity, the shortage of Connellsville coke accounts for about two-fifths of the total restriction.

There is no shortage of pig iron and there has been none since early in the year, the condition being quite different from that obtaining in 1917, when at practically all times the operation of steel works was restricted by an insufficiency of pig iron. The only reason the light supply of pig iron cannot be regarded as representing a shortage is that the steel mills are greatly restricted in shipping their finished product. The shortage of cars continues, while few of the embargoes have been removed, and railroad permits, to ship into or through embargoes, are not granted with much more freedom than formerly. The steel mills shipped finished products in January at the rate of about 60 per cent of capacity. February showed an average rate of about 65 per cent, and at the middle of March shipments are averaging 70 per cent or a trifle more. Meanwhile there is a little accumulation of pig iron, also a little accumulation of ingots. Production of finished steel is slightly less, on an average, than the shipments, as the mills are making an effort to reduce stocks, which at many mills are an encumbrance.

Commercial Demand

As to any appraisal of the market situation and prospects a serious obstacle is the fact that trade currents and influences, usually an object of close scrutiny, cannot be observed at this time. Buyers have a large tonnage on mill books, much of the tonnage long overdue, and this would naturally make them indisposed to make additional purchases. Uncertainty as to prices causes an indisposition to buy for far forward deliveries and thus the volume of buying does not furnish the usual market index. The willingness of many buyers to accept shipments cannot be tested because they are embargoed. Technically the position is that the mill cannot ship by reason of traffic conditions, but one does not know that if traffic conditions were suddenly made normal the consumers would continuously accept the larger shipments that would then be made. Many consumers, perhaps, are hiding behind embargoes and not disclosing their real situation as to the amount of steel they need.

Appearances, so far as they can be observed, are that the strictly commercial demand for steel is extremely limited. Ordinary commercial work is largely suspended. Quite a distorted view may be obtained, however, by observing merely that requirements for steel entirely dissociated from prosecution of the war promise to be very light, because one activity after another transfers itself from the commercial class to the war class. The largest single customer of the steel industry are the railroads, but the buying of railroad material is now a government activity, and large orders are to be placed. Oil development and transport, normally consuming a great deal of steel, is now regarded as a war activity, and so with coal mine equipment and a host of things.

Steel for war has fallen broadly into two categories, the steel that is needed only once, for certain descriptions of equipment, and the steel that will be needed in a steady stream while the war lasts. In the former class, for instance, is steel for building and equipping army cantonments and shipyards, while in the latter class is steel for guns, shells and ships. Demands in the former class are playing out, while demands in the latter are increasing.

On the whole there is very considerable reason for doubting whether there will be enough demand for steel to enable the industry to operate at 85 or 90 per cent of its capacity. As long as traffic conditions prevent the industry from operating at the rate desired the extent of the requirements is not disclosed. At capacity, the steel industry can produce approximately 3,000,000 gross tons of finished rolled steel a month. With fair traffic conditions, but with some labor shortage and troubles of other descriptions, it ought

Current Market Reports

The Iron and Steel Market

Traffic conditions, as affecting the iron and steel industry's operations, have continued to improve, but there is no chance of March making a new record for production as it frequently does. The railroads can clear their congestion and resume normal operations, only slowly, while apart from that is the fact that the exigencies of war, and particularly our share in provisioning our Allies, requires much special movement of freight, interfering with ordinary traffic movement. In particular the movement of foodstuffs from Chicago and other far interior points to seaboard has in the past few weeks tied up a great deal of transportation capacity.

Pig iron production in the fore part of March was at the rate of about 33,000,000 tons a year, while the productive capacity is at least 43,000,000 tons. The restriction in output was wholly by reason of insufficient coke supplies. The by-product ovens at blast furnaces have not been fully supplied with coal, although their supplies have probably been 90 per cent., against 75 per cent or less in January,

to be able to produce 2,500,000 tons a month without much difficulty. It is quite impossible to make up any budget of war and near-war requirements in steel that will total any such tonnage, but this is all theory, and the practical operation of the market in the next few weeks will probably make some definite disclosures.

The present set prices for iron and steel, extended in their operation to March 31 by the announcement of December 28, will probably be reaffirmed by the War Industries Board, either to the end of the year, as desired by the producers, or for an indefinite period. At a meeting of representative manufacturers held in New York Friday, March 1, the matter of conferring with the War Industries Board was left to the Institute committee, without specific instructions. Some interests would prefer slight modifications in the schedule, but the preponderating sentiment is that the schedule is a fairly well balanced one, and as it is reasonably well known that the War Industries Board would be indisposed to advance any prices the trade's natural preference is that no change should be made. It is important to observe that the strategic position of the War Industries Board is quite different from the one it occupied last summer when it sought a voluntary agreement with the producers. At that time ordinary commercial demand was considered an important factor, and this had to be considered when the government had no legal authority as to prices except in the case of its own purchases. At the present time the government purchases greatly preponderate, and at any time the government could set prices, with full legal authority, on this class of business. The result of the situation is that the War Industries Board occupies a very strong position.

Chemical Market

COAL TAR PRODUCTS.—While the inquiry was slightly improved, there was not a great deal of business passing during the interval. The scarcity of some of the important products on the list has resulted in an advance in prices on several items.

Benzol.—The demand has improved slightly and, while there is a little more business passing than during the past few months, the movement continues below normal, with prices unchanged.

Phenol.—Offerings were light, but the demand is in like order, and prices are slightly firmer.

Toluol.—The Government is not permitting the release of any large quantities of material; second hands, however, are offering small quantities and are exacting high prices.

Naphthalene.—The inquiry has improved considerably of late, with prices higher and the supply considerably below normal.

Aniline Oil.—Prices hold steady, although the demand of late has fallen off somewhat.

Beta Naphthol.—Has been fairly active, but the production is sufficient to cover requirements of the trade, and prices are unchanged.

Dimethylaniline.—Has been advanced in price and some producers are offering only on contract.

Ortho Nitro Toluol.—The scarcity of toluol coupled with an increase in the buying inquiry has caused leading producers to advance prices.

Para Nitro Toluol.—The demand is not heavy and, despite the fact that raw material is scarce, prices are unchanged.

Benzaldehyde.—The scarcity of raw material has resulted in the restriction of production, and prices are advanced, with only a few producers offering.

Benzoate of Soda.—Remains in speculative hands and prices are fluctuating in a nervous way according to ideas of holders based on the demand.

HEAVY CHEMICALS.—The general trend of values under this heading has been downward during the past two weeks, due principally to the lack of actual consuming demand and the difficulty of securing export licenses and the resulting curtailment of trade.

Caustic Soda.—A marked decline on caustic values has been noted during the past two weeks, and sales have occurred as low as 4.25c. for material from New York store. The production continues on a large scale and, due to the impossibility of exporting the usual amounts, the domestic output at the moment is probably two or three times in ex-

cess of the domestic production. For shipment from works there have been special sales at 4c., works, but this figure is low and fractional advances have been quoted for distant delivery. There has been but a very limited inquiry for distant deliveries.

Soda Ash.—The movement has been unimportant, and prices are on about the same level as when we last reported. There has been some inquiry for export barrels and for dense ash, but the inquiry has been from comparatively few sources.

Copper Sulphate.—The market has improved under a better inquiry and there have been sales of Nichols brand at 9½c. and 9¼c. The outside brands have been selling at prices ranging from 9c. to 9¼c.

Cyanide of Soda.—A weak market continues, and there have been offerings as low as 36c., although the general trade is asking 42c. and 45c. An increased output has been the cause of the lower situation.

Yellow Prussiate of Potash.—Offerings have been more liberal, and there have been important sales as low as \$1.22, although \$1.25 is more generally quoted. The buying season for prussiates is now approaching and improvement is looked for. Red prussiate has been offered at \$2.80 to \$2.90.

Prussiate of Soda.—Important business has passed at 37½c., and there are sellers now at 38½c. and 39c.

Chlorate of Potash.—An extremely dull situation has prevailed and the product has been difficult to move for either export or domestic account. It is reported that there have been offers as low as 28c., although this was an export lot for which a license could not be secured. Sales, however, of ordinary amounts have occurred at 34c. for crystals ground free of charge.

Bleaching Powder.—A lack of demand has prevailed and there have been offers of material from store at prices ranging from \$1.85 to \$2.00. From works, however, makers quote \$2.25.

Bichromate of Soda.—The buying flurry has continued and there have been a number of important sales at prices ranging from 23c. to 24c. at various points. The production has been well sold and the product has passed into second hands.

Glycerin.—Sales during the last ten days have probably totaled close to 200 cars of dynamite at prices ranging from 65½c. to 66½c. The explosives manufacturers have entered the market in a big way and at the moment of writing are still bidding at 66c. with refiners holding at 68c.

Acetic Acid.—Stocks have dwindled and there are very few offers reported, particularly on the lower tests. The 28 per cent material has been sold at 6¼c. Chicago, but at the moment of writing sellers are asking 8¼c. rolling. Glacial acid is offered at 37c., carboys extra.

Sulphuric Acid.—The movement has been much relieved and tank cars have been coming through more satisfactorily. While considerable business was done early in the interval at \$90.00, drums included, f.a.s., there are offers now of the 66 degree brimstone material at \$75, drums inclusive, f.a.s. In seller's tanks there are offers at \$40.00, seller's tanks, seller's works. Some 60 degree acid has been offered at \$23.00, buyer's tanks, seller's works.

Arsenic.—The Food Administration has fixed a price of 9¼c. at which white arsenic should be sold. As a consequence of this situation the trade is much unsettled as they are somewhat uncertain as to the desires of the Administration. Most of the trade have withdrawn offers but some material is available at 17¼c.

Aqua Ammonia.—Supplies have been almost eliminated from the market. Despite the fact that the Government has fixed a price of 8¼c. for the 26 degree material there has been some trading of a few drums practically daily at prices ranging from 19c. to 23c.

Non-Ferrous Metal Market

Monday, March 11.—There have been no startling developments in these markets. Tin continues to be very scarce for prompt supplies and futures have again advanced.

Copper.—Consumers experienced little difficulty in obtaining adequate supplies during the month of February and there seems to be enough copper for present needs. The refineries are watching the labor situation very closely and

are experiencing some difficulty in holding men owing to higher wages being offered elsewhere. There is a belief that a higher price will be recommended for copper in June when the subject comes up for discussion again. Some of the smaller producers are unable to make a profit at present prices. The price for all grades continues at 23.50 for producers and 24.67½ for jobbers.

Tin.—In February 1280 tons of tin arrived at Atlantic ports and on March 1, only 197 tons was in stock at Atlantic ports. At Pacific ports the arrivals for February were 1548 tons. Total deliveries were 3398 tons. No Straits tin is offered for shipment before June. Banca tin is available at 75 cents for March shipment and 74.50 for April. English, Lamb & Flag is held at 81.50 for March shipment. A little 99 per cent tin is offered on spot at 84 cents.

The monthly statistics compiled by the New York Metal Exchange are interesting and are given as follows:

Tons of 2240 lb.				
Straits				
Shipments during	Feb., 1918.	Jan., 1918.	Feb., 1917.	
To Great Britain	*1,000	*1,500	4,264	
To Continent	* 500	* 500	943	
To United States	*3,500	*2,500	1,048	
Total from Straits	*5,000	*4,500	6,255	
Consumption:				
London deliveries	1,595	1,579	1,117	
Holland deliveries .....	.....	71	85	
United States	3,398	4,642	3,930	
Total	4,993	6,292	5,132	
Stocks at close of month:				
In London—				
Straits, Australia	2,703	3,499	2,927	
Other kinds	482	498	995	
In Holland .....	.....	.....	.....
In United States	197	767	3,027	
Total	3,382	4,764	6,949	
Afloat—				
London	*3,370	*4,085	6,444	
Banka & Billiton	*3,200	*2,600	2,018	
United States	*7,082	*5,500	4,216	
Total afloat				
close of month	*13,652	*12,185	12,678	
Total visible				
supply	Feb. 28, 1918.	Jan. 31, 1919.	Feb. 28, 1917.	
* Estimated.	17,034	16,949	19,627	

Lead.—The Trust price of lead was again raised \$5 per ton to 7½ cents on Feb. 26. The market at the time of writing was dull and the premium for prompt metal had disappeared in the West. Independents are asking 7½ to 7½ cents.

Spelter.—There has been a fair demand for spot spelter and sales have been made as high as 8½ cents New York. At Western points the price has been as low as 7½ cents.

Aluminium.—The President has approved an agreement made between the War Industries Board and the producers of aluminium fixing the price of aluminium at 32 cents per lb. in 50 ton lots f.o.b. shipping point, 98 to 99 per cent material. The conditions of the agreement are: First, that the producers will not reduce the wages now being paid; second, that they will sell to the allies, to the public, and to the Government at the same price; third, that they will take the necessary measures, under the direction of the War Industries Board, for the distribution of the aluminium to prevent it from falling into the hands of speculators, who might increase the price to the public; and, fourth, that they pledge themselves to exert every effort necessary to keep up the production of aluminium so as to insure an adequate supply so long as the war lasts.

Radium.—The price of radium is understood to be in the neighborhood of \$2,800,000 per oz. at present. Before the

war it sold at \$1,000,000 per oz., although it was produced at a considerably lower figure, but not for sale, by the Bureau of Mines in their experimental plant in Colorado.

OTHER METALS

Aluminium, lb., 98-99 per cent, virgin, Gov't price...	.32
Bismuth, lb.	2.50-2.75
Cadmium, lb.	1.50
Nickel, electrolytic, lb.	55.50
Silver, oz. ....	.85%
Platinum, oz.	108.00
Palladium, oz.	135.00-137.00
Cobalt, lb.	3.25-3.50
Magnesium, lb.	2.00
Quicksilver, Cal.	125.00
Quicksilver, Mexican	115.00

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, FEB. 21, 1918

Acetic anhydride	lb.	1.35	1.50
Acetone, drums	lb.	Nominal	
Acid, acetic, 28 per cent.	lb.	.08½	.09
Acetic, 56 per cent.	lb.	Nominal	
Acetic, glacial, 99½ per cent, carboys.	lb.	.37	.38
Boric, crystals	lb.	.13½	.14½
Citric, crystals	lb.	.74½	.75
Hydrochloric, C. P.	lb.	.08	.08½
Hydrochloric, 20 deg.	lb.	.02½	.03
Hydrochloric, conc., 22 deg.	lb.	.03	.03½
Hydrofluoric, 30 per cent, in barrels.	lb.	.06	.06½
Lactic, 44 per cent.	lb.	.15	.15½
Lactic, 22 per cent.	lb.	.05½	.06½
Nitric, 36 deg.	lb.	Nominal	
Nitric, 42 deg.	lb.	.09½	.09½
Oxalic, crystals	lb.	.44	.45
Phosphoric, 47-50 per cent crude.	lb.	.07½	.10
Phosphoric, ref. 50 per cent.	lb.	.26	
Picric	lb.	Nominal	
Pyrogallol, resublimed.	lb.	3.10	3.15
Sulphuric, 60 deg.	ton	...	35.00
Sulphuric, 66 deg.	ton	40.00	45.00
Sulphuric, oleum (Fuming), tank cars.	ton	77.00	80.00
Tannic, U. S. P., bulk.	lb.	1.30	1.35
Tartaric, crystals	lb.	.75	.78
Tungstic, per lb. of W.	lb.	1.80	1.90
Alcohol, sugar cane, 188 proof.	gal.	4.93	4.95
Alcohol, wood, 95 per cent.	gal.	1.35	1.38
Alcohol, denatured, 180 proof.	gal.	.70	.72
Alum, ammonia lump.	lb.	.04	.04½
Alum, chrome ammonium.	lb.	.18½	.19
Alum, chrome potassium.	lb.	.20½	.22
Alum, chrome sodium.	lb.	.12½	.13
Alum, potash lump.	lb.	.08½	.09½
Aluminium sulphate, technical.	lb.	.01½	.02½
Aluminium sulphate, iron free.	lb.	.02½	.03½
Ammonia aqua, 26 deg. carboys.	lb.	.24	.25
Ammonia, anhydrous.	lb.	Nominal	
Ammonium carbonate.	lb.	.11	.12
Ammonium nitrate.	lb.	(Fixed price)	.14
Ammonium sulphate domestic.	lb.	.07½	.07½
Amyl acetate.	gal.	5.00	5.25
Arsenic, white.	lb.	.17½	.17½
Arsenic, red.	lb.	.65	.70
Barium carbonate, 99 per cent.	ton	80.00	90.00
Barium carbonate, 97-98 per cent.	ton	65.00	67.00
Barium chloride.	ton	65.00	85.00
Barium sulphate (Blanc Fixe, powder)	lb.	.03½	.04
Barium nitrate.	lb.	.08½	.08½
Barium peroxide, basis 70 per cent.	lb.	.30	.32
Bleaching powder, 35 per cent chlorine.	lb.	.02	.02½
Borax, crystals, sacks.	lb.	.07½	.08½
Brimstone, crude.	ton	Nominal	
Bromine, technical.	lb.	.75	...
Calcium, acetate, crude.	lb.	Nominal	
Calcium, carbide.	lb.	.14½	.14½
Calcium chloride, 70-75 per cent, fused, lump.	ton	23.00	27.00
Calcium peroxide.	lb.	1.60	1.70
Calcium phosphate.	lb.	.34	.35
Calcium sulphate 98-99 per cent.	lb.	.09	.09½
Carbon bisulphide.	lb.	.08	.10
Carbon tetrachloride, drums.	lb.	.15½	.16
Carbonyl chloride (phosgene).	lb.	...	...
Caustic potash, 88-92 per cent.	lb.	.84	.85
Caustic soda, 76 per cent.	lb.	.04½	.04½
Chlorine, liquid.	lb.	.18	.18
Cobalt oxide.	lb.	1.60	1.65
Copperas.	lb.	.01½	.01½
Copper carbonate.	lb.	.30	.40
Copper cyanide.	lb.	.75	.78
Copper sulphate, 99 per cent, large crystals.	lb.	.09½	.09½
Cream of tartar, crystals.	lb.	.50	.61
Epsom salt, bags.	lb.	.03½	.03½
Formaldehyde, 40 per cent.	lb.	.19½	.20
Glauber's salt.	100 lb.	1.25	2.00
Glycerine, bulk, C. P.	lb.	.68½	.69
Iodine, resublimed.	lb.	4.25	4.35
Iron oxide.	lb.	.13	.15
Lead, acetate, white crystals.	lb.	.17	.18
Lead arsenate (Paste).	lb.	.15	.18
Lead nitrate.	lb.	.15	.16
Litharge, American.	lb.	.09½	.11½
Lithium carbonate.	lb.	1.50	2.00
Manganese dioxide, U. S. P.	lb.	.70	.75
Magnesium carbonate, technical.	lb.	.10½	.11
Nickel salt, single.	lb.	.12½	.13
Nickel salt, double.	lb.	.12	.14
Phosgene, see Carbonyl chloride.	lb.	...	...
Phosphorus, red.	lb.	1.40	1.50
Phosphorus, yellow.	lb.	1.55	1.60
Potassium bichromate.	lb.	.44	.46
Potassium bromide granular.	lb.	1.35	1.50
Potassium carbonate calcined, 85-90 per cent.	lb.	.95	1.05
Potassium chlorate, crystals.	lb.	.36	.40
Potassium cyanide, 98-99 per cent.	lb.	2.50	2.75
Potassium iodide.	lb.	3.75	3.80
Potassium muriate 80-85 p. c. basis of 80 p. c.	ton	340.00	350.00
Potassium nitrate.	lb.	.27	.31
Potassium permanganate (U. S. P.).	lb.	4.00	4.10

Potassium prussiate, red.....	lb.	2.80	—	2.90
Potassium prussiate, yellow.....	lb.	1.22	—	1.25
Potassium sulphate, 90-95 p.c. basis 90 p.c.....	ton	Nominal		
Rochelle salts.....	lb.	.39	—	.39½
Sal ammoniac, gray gran.....	lb.	.15½	—	.17
Sal ammoniac, white gran.....	lb.	.15	—	.16
Sal soda.....	100 lb.	1.25	—	1.30
Salt cake.....	ton	25.00	—	26.00
Silver cyanide, based on market price of silver.....	oz.	.54½	—	.55
Silver nitrate.....	oz.	.54½	—	.55
Soda ash, 55 per cent, light, flat.....	100 lb.	2.80	—	2.90
Soda ash, 55 per cent, dense, flat.....	100 lb.	3.60	—	4.00
Sodium acetate.....	lb.	.16½	—	.17
Sodium bicarbonate, domestic.....	lb.	.02½	—	.03
Sodium bicarbonate, English.....	lb.	.23½	—	.24
Sodium bichromate.....	lb.	.08	—	.10
Sodium bisulphite, powd.....	lb.	.36	—	.40
Sodium chloride.....	lb.	.17	—	.18
Sodium cyanide.....	lb.	.02½	—	.03
Sodium hyposulphite.....	lb.	2.50	—	4.60
Sodium molybdate, per lb. of Mo.....	100 lb.	4.50	—	4.60
Sodium nitrate, 95%.....	lb.	.35	—	.36
Sodium nitrite.....	lb.	.45	—	.50
Sodium peroxide.....	lb.	.03½	—	.04½
Sodium phosphate.....	lb.	.38½	—	.40
Sodium prussiate, yellow.....	lb.	.04½	—	.05
Sodium silicate, liquid (60 deg.).....	lb.	.02½	—	.03
Sodium sulphide, 30 per cent., crystals.....	lb.	.04½	—	.05
Sodium sulphide, 60 per cent., fused.....	lb.	.05	—	.06
Sodium sulphite.....	lb.	.25	—	.35
Strontium nitrate.....	lb.	.06	—	.06½
Sulphur chloride, drums.....	lb.	.15	—	.40
Sulphur dioxide, liquid, in cylinders.....	100 lb.	4.05	—	4.60
Sulphur, flowers, sublimed.....	100 lb.	3.70	—	3.85
Sulphur, roll.....	ton	Nominal		
Sulphur, crude.....	lb.	.75	—	.90
Tin bichloride, 50 deg.....	lb.	.25	—	.30
Tin oxide.....	lb.	.13	—	.16
Zinc carbonate.....	lb.	Nominal		
Zinc chloride.....	lb.	.14	—	.16
Zinc cyanide.....	lb.	.14	—	.15
Zinc dust, 350 mesh.....	lb.	.06	—	.07
Zinc oxide, American process XX.....	lb.			
Zinc sulphate.....	lb.			

Coal Tar Products (Crude)

Benzol, pure, water white.....	gal.	.35	—	.40
Benzol, 90 per cent.....	gal.	Nominal		
Toluol, pure water white.....	gal.	.35	—	.50
Xylol, pure, water white.....	gal.	.17	—	.22
Solvent naphtha, water white.....	gal.	.13	—	.16
Solvent naphtha, crude, heavy.....	gal.	.33	—	.35
Creosote oil, 25 per cent.....	gal.	.29	—	.30
Dip oil, 20 per cent.....	gal.	8.00	—	20.00
Pitch, various grades.....	ton	1.05	—	1.10
Carbolic acid, crude, 95-97 per cent.....	lb.	.60	—	.65
Carbolic acid, crude, 80 per cent.....	lb.	.35	—	.38
Carbolic acid, crude, 25 per cent.....	lb.	.18	—	.20
Cresol, U. S. P.....	lb.			

Intermediates, Etc.

Alpha naphthol, crude.....	lb.	1.00	—	1.25
Alpha naphthol, distilled.....	lb.	1.60	—	2.00
Alpha naphthylamine.....	lb.	.60	—	.62
Aniline oil, drums extra.....	lb.	.27	—	.28
Aniline salts.....	lb.	.32	—	.34
Anthracene, 80 per cent.....	lb.	.50	—	.65
Benzaldehyde (f.f.c.).....	lb.	4.75	—	5.50
Benzidine, base.....	lb.	1.75	—	1.85
Benzidine, sulphate.....	lb.	1.40	—	1.50
Benzoic acid U. S. P.....	lb.	5.25	—	5.50
Benzoate of Soda, U. S. P.....	lb.	4.30	—	4.75
Benzyl chloride.....	lb.	2.25	—	2.50
Beta naphthol benzoate.....	lb.	10.00	—	12.00
Beta naphthol, sublimed.....	lb.	.85	—	.90
Beta naphthylamine, sublimed.....	lb.	2.65	—	.18
Dichlor benzol.....	lb.	4.00	—	5.00
Diethylamine.....	lb.	.35	—	.40
Dinitro benzol.....	lb.	.45	—	.42
Dinitrochlorbenzol.....	lb.	.55	—	.60
Dinitronaphthalene.....	lb.	.55	—	.60
Dinitrotoluol.....	lb.	.60	—	.65
Dinitrophenol.....	lb.	.63	—	.65
Dimethylamine.....	lb.	1.00	—	1.10
Diphenylamine.....	lb.	2.25	—	2.50
H-acid.....	lb.	1.85	—	2.00
Metaphenylenediamine.....	lb.	.19	—	.22
Monochlorbenzol.....	lb.	.10½	—	.11
Naphthalene, flake.....	lb.	.12	—	.14
Naphthalene, balls.....	lb.	1.40	—	1.50
Naphthalonic acid, crude.....	lb.	1.00	—	1.10
Naphthylamine-di-sulphonic acid.....	lb.	.45	—	.50
Nitro naphthalene.....	lb.	.60	—	.55
Nitro toluol.....	lb.	.15	—	.18
Ortho-amidophenol.....	lb.	1.25	—	1.30
Ortho-dichlor-benzol.....	lb.	.75	—	1.00
Ortho-toluidine.....	lb.	3.50	—	4.00
Ortho-nitro-toluol.....	lb.	4.00	—	5.00
Para-amidophenol, base.....	lb.	.12	—	.15
Para-amido-phenol, H. Ch.....	lb.	1.25	—	1.30
Para-dichlor-benzol.....	lb.	1.50	—	1.60
Paranitraniline.....	lb.	3.00	—	3.50
Para-nitro-toluol.....	lb.	2.25	—	2.50
Paraphenylenediamine.....	lb.	4.50	—	5.00
Para-toluidine.....	lb.	.53½	—	.55
Phthalic acid anhydride.....	lb.	6.00	—	7.00
Phenol, U. S. P.....	lb.	9.00	—	10.00
Resorcin, technical.....	lb.	1.00	—	1.10
Resorcin, pure.....	lb.	1.85	—	2.00
Salicylic acid.....	lb.	.32	—	.35
Salol.....	lb.	2.60	—	2.85
Sulphanilic acid, crude.....	lb.	.75	—	.85
Tolidin.....	lb.			
Toluidine-mixture.....	lb.			

Petroleum Oils

Crude (at the Wells)

Pennsylvania.....	bbl.	4.00	—	.....
Corning, Ohio.....	bbl.	2.85	—	.....

Somerset, Ky.....	bbl.	2.60	—	.....
Waco, Ohio.....	bbl.	2.38	—	.....
Indiana.....	bbl.	2.08	—	.....
Illinois.....	bbl.	2.22	—	.....
Oklahoma and Kansas.....	bbl.	2.00	—	.....
Caddo, La., light.....	bbl.	2.00	—	.....
Corsicana, Tex., light.....	bbl.	2.00	—	.....
California.....	bbl.	.98	—	1.32
Gulf Coast.....	bbl.	1.00	—	.....

Fuel Oil

New York.....	gal.	.11	—	.....
Pittsburgh.....	gal.	.07½	—	.10
Oklahoma-Kans.....	bbl.	1.50	—	2.35
Texas.....	bbl.	1.50	—	1.90
Los Angeles.....	bbl.	1.52	—	.....
San Francisco.....	bbl.	1.45	—	.....

Gasoline (Wholesale)

New York.....	gal.	.24	—	.....
Boston.....	gal.	.25	—	.....
Pittsburgh.....	gal.	.26	—	.....
Chicago.....	gal.	.21	—	.....
Oklahoma.....	gal.	.25	—	.....
San Francisco.....	gal.	.20	—	.....

Lubricants

Black, reduced, 20 gravity, 25-30 cold test.....	gal.	.21	—	.22
Cylinder, light.....	gal.	.36	—	.38
Cylinder, dark.....	gal.	.35	—	.36
Paraffine, high viscosity.....	gal.	.40	—	.41
Paraffine, 903 sp. gr.....	gal.	.33	—	.34
Paraffine, .865 sp. gr.....	gal.	.22	—	.23

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f.o.b. Florida.....	gal.	.44	—	.....
Pine oil, steam distilled, sp. gr. 0.925-0.940.....	gal.	.53	—	.....
Pine oil, destructively distilled.....	gal.	.49	—	.53
Pine-tar oil, sp. gr. 1.025-1.035.....	gal.	.35	—	.....
Pine-tar oil, double refined, sp. gr. 0.965-0.990.....	gal.	.40	—	.....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works.....	gal.	.37	—	.....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works.....	gal.	.26	—	.....
Pine tar, thin, sp. gr. 1.060-1.080.....	gal.	.30	—	.....
Turpentine, crude, sp. gr. 0.980-1.000.....	gal.	.40	—	.....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990.....	gal.	.19	—	.....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08.....	gal.	.19	—	.....
Wood creosote, ref. f.o.b. Florida.....	gal.	.31	—	.....

Vegetable and Other Oils

China wood oil.....	lb.	.21	—	.22
Cottonseed oil, crude.....	lb.	.17½	—	.18
Lined oil, raw, cars.....	gal.	1.40	—	1.42
Peanut oil, crude.....	gal.	1.37	—	.....
Rosin oil, first run.....	gal.	.35	—	.....
Rosin oil, fourth run.....	gal.	.66	—	.....
Soya bean oil, Manchuria.....	lb.	.18½	—	.19
Turpentine, spirits.....	gal.	.45	—	.....

Miscellaneous Materials

Barytes, floated, white, foreign.....	ton	40.00	—	50.00
Barytes, floated, white, domestic.....	ton	30.00	—	36.00
Beeswax, white, pure.....	lb.	.56	—	.64
Casein.....	lb.	.22	—	.30
Chalk, light, precipitated, English.....	lb.	17.50	—	36.00
China clay, imported, lump.....	ton	12.50	—	20.00
China clay, domestic, lump.....	ton	8.00	—	12.00
Feldspar.....	100 lb.	1.00	—	1.50
Fuller's earth, powdered.....	lb.	.65	—	.75
Osokerite, crude, brown.....	lb.	.75	—	1.00
Osokerite, American, refined, white.....	lb.	.10	—	.11½
Red lead, dry, carloads.....	ton	7.00	—	.....
Rosin, 280 lb.....	bbl.	10.00	—	12.50
Soapstone.....	ton	15.00	—	22.00
Talc, American, white.....	ton	.09	—	.10
White lead, dry.....	lb.			

Refractories, Etc.

(F.O.B. Works)

Chrome brick.....	net ton	Nominal		.....
Chrome cement, Grecian.....	net ton	Nominal		.....
Clay brick, 1st quality fireclay.....	per 1000	50.00	—	55.00
Clay brick, second quality.....	per 1000	35.00	—	40.00
Magnesite, raw.....	ton	30.00	—	35.00
Magnesite, calcined.....	ton	35.00	—	36.00
Magnesite, Grecian, dead burned.....	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½.....	net ton	135.00	—	140.00
Silica brick.....	per 1000	50.00	—	60.00

Ferroalloys

Ferrocobalt, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.....	ton	160.00	—	.....
Ferrocobalt.....	lb.	18.00	—	.....
Ferrocromium, per lb. of Cr.....	lb.	.50	—	.....
Ferromanganese, domestic.....	ton	250.00	—	.....
Ferromanganese, English.....	ton	325.00	—	.....
Ferromolybdenum, per lb. of Mo.....	lb.	5.00	—	.....
Ferrosilicon, 75 per cent, f.o.b. N. Y.....	ton	170.00	—	195.00
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh.....	ton	100.00	—	175.00
Ferrosilicon, 50 per cent, contract.....	ton	2.30	—	2.35
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh.....	lb.	7.00	—	.....
Ferroumium, f.o.b. works, per lb. of U.....	lb.	4.00	—	5.00
Ferrovanadium, f.o.b. works.....	lb.			

Ores and Semi-finished Products

Antimony ore, per unit.....	1.60	—	1.75
Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit.....	1.50	—	1.60
Chrome ore, 43 per cent and over, New York, per unit.....	1.50	—	.....
Manganese ore, 48 per cent and over, per unit.....	1.20	—	.....
Manganese ore, chemical.....	80.00	—	100.00
Molybdenite, per lb. of MoS ₂	2.10	—	2.15
Tungsten, Scheelite, per unit of WO ₃	20.00	—	24.00
Tungsten, Wolframite, per unit of WO ₃	20.00	—	24.00
Uranium oxide, 96%.....	3.25	—	3.60
Vanadium pentoxide, 99%.....	10.50	—	.....
Pyrites foreign.....	.17	—	.17½
Pyrites domestic.....	.28	—	.30

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

THE AMERICAN CEEULUOZ & CHEMICAL MANUFACTURING COMPANY, Dover, Del. Capital, \$25,000,000. To manufacture chemicals and celluloid products. Incorporators: Henry Bigham, New York; Frank C. Welles, New Rochelle; and O. R. Houston, Great Neck Station, N. Y.

THE ATLAS FOUNDRY COMPANY, Newark, N. J. Capital, \$125,000. To operate a local plant for the production of iron and brass products.

THE AUDUBON PAPER STOCK COMPANY, Inc., New York. Capital, \$10,000. To manufacture paper. Incorporators: Solomon Ash, A. E. Engeman, New York; and William H. Hitchcock, Jersey City, N. J.

THE BEHRE CHEMICAL WORKS, Madison, N. J. Capital, \$50,000. To manufacture chemicals and allied products. Incorporators: James Benny, Burgess A. Cruden, and A. S. Doolan, 27 East Eighteenth Street, Bayonne.

THE BIG VEIN LEAD & ZINC COMPANY, Miami, Okla. Capital, \$250,000. To mine for lead and zinc. Incorporators: W. A. Doty, Miami; G. B. Crumline and J. A. Utterback, Oklahoma City.

THE BLYTHE COTTON OIL COMPANY, Los Angeles, Cal. Capital, \$125,000. To operate a plant for the production of cotton seed oil. Incorporators: R. H. McLarn, G. G. and J. V. Blard, A. C. Anderson and Howard Prowse, Los Angeles.

THE BRITISH-AMERICAN METALLURGICAL CORPORATION, New York. Capital, \$5,000,000. To engage in the treatment of ores and the production of chemical products. Incorporators: A. W. Britton, S. B. Howard and G. V. Reilly, New York.

THE BURNET TEXAS GRAPHITE COMPANY, Burnet, Tex. Capital, \$62,500. To mine for graphite. Incorporators: P. B. McCable, Burnet; W. B. Garrett, Austin; and C. J. Price, Topeka, Kan.

THE CALIFORNIA COTTON OIL COMPANY, Los Angeles, Cal. Capital, \$100,000. To operate a plant for the production of cotton seed oil. Incorporators: J. P. Conduit, L. F. Martin, Los Angeles; and T. W. McDevitt, Phoenix, Ariz.

THE CLAREMONT MARL PRODUCTS COMPANY, Claremont, Va. Capital, \$250,000. To manufacture marl products for fertilizer use. Incorporators: H. J. Arrington, Claremont; and C. D. Gilliam, Richmond.

THE COLE CHEMICAL COMPANY, St. Louis, Mo. Capital, \$200,000. To manufacture chemicals and allied products. B. L. Cole is the principal incorporator.

THE CONSOLIDATED ZINC & SMELTING COMPANY, Inc., New York. Capital, \$3,000,000. To engage in the mining, milling and concentrating of lead and zinc ores, etc.

THE COOKS FALLS DYE WORKS, Inc., New York. Capital, \$30,000. To manufacture dyestuffs, etc. Incorporators: W. and H. and A. Hine, Cedarhurst, Brooklyn.

THE CROTON COLOR & CHEMICAL COMPANY, Croton, New York. Capital, \$150,000. To manufacture chemicals and dyestuffs, etc. Incorporators: H. P. Thrig, E. R. Voltmer and F. C. Schmitz, 31 Union Square.

THE DANIEL BOONE MINING COMPANY, Quapaw, Okla. Capital, \$150,000. To mine for lead and zinc. Incorporators: C. H. Birt, Muskogee; J. E. Jenkins, Springfield, Mo.; and A. Avery, Oronogo, Mo.

THE JAMES F. DUFFY CORPORATION, Bronx, N. Y. Capital, \$15,000. To manufacture chemicals and lubricant products. Incorporators: J. S. Michom, H. G. Fenton and J. F. Duffy, 182 White Plains Avenue.

THE DUPLICO MANUFACTURING COMPANY, New Brunswick, N. J. Capital, \$100,000. To manufacture carbon paper and kindred specialties. Incorporators: J. H. Helm, I. B. Glueckfield and George R. Morrison, New Brunswick.

THE ELECTRIC STEEL COMPANY OF AMERICA, Dover, Del. Capital, \$4,000,000. To manufacture iron, steel and other metals.

THE EXPORT NITRO-PHOSPHO COMPANY, Newark, N. J. Capital, \$120,000. To manufacture phosphates and other fertilizers.

Incorporators: George R. Swain, John I. Sipp and C. Jacobs, Newark.

THE F. & G. CHEMICAL WORKS, Brooklyn, N. Y. Capital, \$5,000. To manufacture chemicals. Incorporators: D. Lenkowsky and M. J. and H. Lesser, 277 Pennsylvania Avenue, Brooklyn.

THE FEDERAL SOAP CORPORATION, New York. Capital, \$30,000. To manufacture soap products. Incorporators: R. K. Dehler, A. H. Rees and C. W. Harlow, 150 Nassau Street.

THE FLORIDA GLASS COMPANY, Tampa, Fla. Capital, \$250,000. To manufacture glass and glassware of various kinds. C. J. Earley, president; Paul T. Davis, secretary.

THE GOODYEAR MINING COMPANY, Winburne, Pa. Capital, \$200,000. To engage in a general mining business. Robert H. Somerville is treasurer and principal incorporator.

THE GRAY INDUSTRIAL LABORATORIES, Elizabeth, N. J. Capital, \$125,000. To engage in the treatment of chemicals and chemical products. Incorporators: Thomas T. Gray, Frank A. Urner and Frank B. Mason, all of Elizabeth.

HANSEN, OLSEN & COMPANY, New York. Capital, \$20,000. To manufacture paints and varnishes, etc. Incorporators: H. J. Hansen, O. Olsen and W. Ferguson, 27 Cedar Street.

THE HEBRON ROLLER MILLS COMPANY, Hebron, N. D. Capital, \$10,000. To operate a local rolling mill. Incorporators: Eugene Weigel, Fred Schwenkand V. Ungerecht.

THE HOWE RUBBER COMPANY, Los Angeles, Cal. Capital, \$200,000. To manufacture rubber goods. Incorporators: E. A. Sattler, New Brunswick, N. J.; C. A. Mullen, San Francisco; and E. M. Reighard, Los Angeles.

THE HUDSON FOUNDRY COMPANY, New York. Capital, \$20,000. To operate a local foundry. Incorporators: J. C. Garrett and J. Mittleman, 27 William Street.

THE INDIA PRODUCTS COMPANY, New York. Capital, \$30,000. To manufacture chemicals and allied products. Incorporators: E. F. and E. Groeniger and B. Bernbaum, 320 Broadway, New York.

THE JOSIAH SMITH PHENYLE COMPANY, Inc., Yonkers, N. Y. Capital, \$25,000. To manufacture paints, disinfectants, chemicals, etc. Incorporators: J. R. Roberson, F. M. Roberson and H. Raynes, 368 South Broadway, Yonkers.

THE LIBERTY MACHINE TOOL & DIE COMPANY, Newark, N. J. Capital, \$80,000. To manufacture machine tools, dies, etc. Incorporators: Albert W. Wenzel, Charles L. Barrows, Newark; and H. M. Bailey, Irvington.

THE LOWER KAHILUNA MINING COMPANY, Inc., New York. Capital, \$250,000. To engage in mining and metallurgical operations. Incorporators: H. N. Armstrong, M. S. Mackay and H. Peters, 14 Wall Street, New York.

THE LYNCHBURG GLASS WORKS, Lynchburg, Va. Capital, \$300,000. To manufacture glass and glassware. Incorporators: N. D. Eller, D. B. Ryland, Lynchburg.

THE MINERAL RIDGE MANGANESE CORPORATION, Strasburg, Va. Capital, \$250,000. To mine for manganese. Incorporators: William B. Shaffer, Nazareth, Pa., and Charles F. Nelson, Strasburg.

THE NATIONAL ANODE COMPANY, Passaic, N. J. Capital, \$100,000. To engage in the production of copper castings. Incorporators: Albert R. Bray, G. W. Bray and William F. Rothlisberger, Newark.

THE NUTRO-PRYO CORPORATION, New York. Capital, \$50,000. To manufacture chemical preparations, etc. Incorporators: L. and J. Rueff-Jordan and L. Bugbee, 447 Fort Washington Avenue.

THE ORES CONCENTRATION COMPANY, Jersey City, N. J. Capital, \$20,000. To engage in the concentration of ores. Incorporators: Ernest S. Hirschberg, Arthur L. Woodland and Paul F. Hauser, Jersey City.

THE PRESTON TRADING COMPANY, Inc., New York. Capital, \$50,000. To manufacture paper and wood pulp. Incorporators:

H. E. Herman, A. O. Ernst and G. G. Newhouse, 170 West Seventy-fourth Street.

THE REILLY-EDWARD COMPANY, Dover, Del. Capital, \$25,000. To manufacture fertilizers. Incorporators: Frank S. Reilly, Baltimore, Md.; and W. T. Edwards, Readville, Va.

THE REPUBLIC OIL & SULPHUR COMPANY, New York. Capital, \$2,000,000. To engage in the production of oil, gas, sulphur, etc. Incorporators: R. Eichman and Louis E. Jump, New York.

THE E. N. ROWELL COMPANY, INC., Batavia, N. Y. Capital, \$25,000. To manufacture paper, etc. Incorporators: E. N. Rowell, C. H. Ruprecht, Batavia, and E. G. Buell, 368 Broadway, N. Y.

THE SEEB PRODUCTS CORPORATION, Wilmington, Del. Capital, \$100,000. To manufacture chemicals and sanctuary oils, etc. Incorporators: M. M. Clancy, C. L. Rimplinger and F. A. Armstrong.

THE SHELBY CHEMICAL COMPANY, Dover, Del. Capital, \$250,000. To manufacture charcoal and acetate of lime. Incorporators: M. L. Rogers, L. A. Irwin and William G. Singer, Wilmington.

THE SOUTHERN CHEMICAL COMPANY, El Paso, Tex. Capital, \$20,000. To engage in the production of saline products. David Russek is the principal incorporator.

STEIN, HALL & COMPANY, New York. Capital, \$2,000,000. To manufacture chemicals. Incorporators: W. S. Goldfrank, W. E. Mann and J. C. Guggenheimer, 27 William Street.

THE STIEGLITE-TRIEBER COMPANY, New York. Capital, \$70,000. To engage in the refining and smelting of metals. Incorporators: F. J. Trieber, L. and A. Stieglitz, 228 Pearl Street.

THE UNION CHEMICAL GLASSWARE COMPANY, Bronx, N. Y. Capital, \$20,000. To manufacture chemical glassware. Incorporators: J. S. Einshon, D. Buegeleisen and A. L. P. Pollack, 601 West 168th Street.

THE UNITED LEAD & ZINC COMPANY, Oklahoma City, Okla. Capital, \$50,000. To mine for lead and zinc. Incorporators: L. B. Grant, R. B. Halliburton and W. C. Brissey.

THE WILLIAMS CHEMICAL CORPORATION, Dover, Del. Capital, \$10,000,000. To manufacture chemicals and allied products. Incorporators: William A. Rogers, Philip L. Nieser and Joseph F. Curtin, all of New York.

THE WILLIAM WATERALL & COMPANY, Camden, N. J. Capital, \$125,000. To manufacture paints, white lead, etc. Incorporators: Samuel A. Matlack, Thomas G. Hawke and Ernest W. Holdt.

Construction and Operation

Alabama

ASHLAND.—The Sutton Steele & Steele Manufacturing Milling & Mining Company has completed its organization plans, and will install new dry process with dedusting, classifying and concentrating machinery in its plant to have an output of approximately 50 tons of lead and zinc every ten hours. Hugh B. Evans is president and manager.

ASHLAND.—The Graphite Mills, which recently increased their capital from \$80,000 to \$250,000, is now developing 80 acres of graphite properties, having a capacity of about 200 tons per ten hours. The company has entirely completed the installation of crushing, classifying and concentrating machinery at a cost of about \$60,000.

GADSDEN.—G. W. Heber and N. H. Sewall are considering plans for the development of about 400 acres of manganese property located four miles from Ivalee.

LINEVILLE.—The Liberty Graphite Company has recently completed the installation of new machinery in its plant to provide for an increase in its capacity to about 150 tons daily. Leo K. Steiner is president.

TRUSSVILLE.—The Birmingham-Trussville Iron Company has completed extensive improvements at its furnace, and is planning to inaugurate operations at an early date.

Arizona

KINGMAN.—The Standard Mineral Company is planning for the early construction of a new 100-ton mill at its property to provide for increased capacity. The company will soon commence on extensive development work, and arrangements have been made for the installation of a large quan-

tity of new machinery, including gas engines, compressors, pumps and machine drills.

KINGMAN.—Walter H. Brown and associates are planning for the immediate construction of a new milling plant on the Golconda Extension.

KINGMAN.—Sitton & Murphy are planning for the immediate development of the old Shipp mine in the Aquarius mountains. This mine was formerly famous as a silver producer, and it is held that the vein is rich in copper.

Arkansas

WARREN.—Fire, on Feb. 26, partially destroyed the plant of the Warren Cotton Oil & Manufacturing Company, with total loss estimated at \$125,000. It is said the plant will be immediately rebuilt.

FORT SMITH.—Announcement has been made of the merger of the Ozark Refining Company and the Prospect Oil & Gas Company, to be capitalized at \$1,500,000, and known as the Ozark Oil & Refining Company. The new company is planning for extensive development work in the Humboldt, Kan., field, and eight new wells will be sunk as soon as the weather conditions permit. Extensive improvements will be made at the plant of the Ozark Refining Company, including the installation of new machinery to increase the capacity from 300 to 600 barrels, to be increased ultimately to 1500 barrels, the latter work being estimated to cost \$40,000.

California

LOS ANGELES.—The American Dye Works, corner Washington Street and Griffith Avenue, has had plans prepared for the construction of a new shop building, about 20 x 100 ft., at 810 East Washington Street.

LOS ANGELES.—The California-Burdett Oxygen Company, Vernon, near Los Angeles, has completed the construction of extensive additions to its plant for the production of oxyacetylene gas.

LOS ANGELES.—The American Cement Products Company, 2348 Long Beach Avenue, manufacturer of steel reinforced-concrete specialties, is planning to equip a section of its plant for the manufacture of pipe, fence posts and kindred products. E. B. Blinn is president.

FILLMORE.—The Ventura Refining Company has completed the construction of a new local plant for the extraction of wax from its lubricating stock. The new plant will be operated as a by-product works.

ETNA.—I. J. Luce of Seattle, Wash., and John M. Tetherow of Grant's Pass, Ore., who recently acquired the Blue Jene gold mine near Etna operated by the Siskiyou Syndicate, have commenced the construction of a large new stamp-mill, and are planning for extensive developments in the property.

MONTEZUMA.—J. C. Heald has commenced alterations and improvements in his mill in the Nashville district, to provide for increased capacity, and it is anticipated that the work will be completed at an early date.

PILOT HILL.—Extensive improvements are being made at the mill which formerly operated on gold ore from the Buzzard mine. New concentrators are also being provided for the treatment of chrome ore from the Pilot Hill and Salmon Falls districts. It is expected that the work will be completed and operation inaugurated at an early date.

BEAUREGARDE.—Plans have been completed for the construction of a large new 150-ton mill at the group of tungsten claims on Pine Creek in the White Mountains, which were recently taken over by new interests. It is also planned to construct a new electric power line. Cooper Shapley is manager.

Colorado

ELDORA.—Rapid progress is being made in the construction of a large new mill at the Huron gold mine, and it is expected that the work will be completed in the near future.

CLIMAX.—The Climax Molybdenum Company is rushing to completion the construction of its new 250-ton mill for the handling of its molybdenum. The company has also made arrangements for housing 185 of its employees. It is a subsidiary of the American Metal Company. J. M. White is manager.

BLACKHAWK.—Robert Wilkinson and associates have completed the organization of the Powers Mining, Milling & Leasing Company, and taken over the Powers mine in the Russell district. The new company is planning for the installation of new machinery, including electric pumps, air-com-

pressors, etc., at the mine, which is said to be one of the best copper producers in Gilpin County.

BRECKENRIDGE.—Plans are under consideration for the construction of a new mill at the Royal Tiger mine. T. A. Brown is superintendent.

CLIMAX.—The Pingrey Mines Company has commenced extensive development of its molybdenum properties in the Black Metal group of claims on the Bartlett Mountain, and plans are now being completed for the construction of a new 500-ton concentration plant. O. A. King is manager.

Delaware

WILMINGTON.—The nineteen-inch mill at the local plant of the Midvale Steel Company was recently severely damaged, with total loss estimated at \$75,000. It is said the destroyed plant will be immediately rebuilt.

WILMINGTON.—The Sugar Refining Company is having preliminary plans prepared for the erection of a large new sugar refinery and power house on the Delaware River. The entire project is estimated to cost about \$10,000,000.

Florida

TAMPA.—W. M. Brooks, Tampa, and J. B. Porter, Buffalo, N. Y., have recently acquired extensive phosphate properties near Tampa, and are planning for the immediate installation of a large mining plant for development.

Georgia

SAVANNAH.—The Savannah Warehouse & Compress Company is planning for extensive additions to its high-density cotton compress plant, to provide for increased capacity, the entire work being estimated to cost about \$200,000. Col. G. Arthur Gordon is president.

Idaho

SAGLE.—The Armstead Mines Company is considering plans for the construction of a large new mill at its properties in Bonner County during the coming spring. H. H. Armstead is president.

Illinois

CHICAGO.—The Standard Steel Castings Company is making rapid progress in the construction of a new one-story plant at Clearing, Ill. The structure will be about 100 x 200 ft., and is estimated to cost \$100,000.

CHICAGO.—The American Coconut Butter Company, 2531 West Eighteenth Street, has commenced the erection of a new five-story refinery and power house, about 61 x 80 ft., at 2822-26 South Kilbourne Avenue. The new plant is estimated to cost about \$60,000.

CHICAGO.—Work has been commenced by the Union Special Machine Company, West Kinzie Street, on the construction of a new three-story and basement plant, about 100 x 100 ft., at 300-14 West Kinzie Street, to cost \$250,000. The George A. Fuller Company, 140 South Dearborn Street, has the contract for erection.

CHICAGO.—The American Clay Machinery Company is building a new one and two-story plant at Mansfield, Ohio. The structure will be about 120 x 300 ft., and will cost \$80,000. The H. A. Peters Company, 19 South La Salle Street, is the contractor.

LOCKPORT.—The Coke Products Manufacturing Company is making rapid progress in the construction of a large new mill for the manufacture of coke products.

Indiana

INDIANAPOLIS.—The Parker Tire & Rubber Company, Merchants' Bank Building, is considering the construction of a new one-story brick, steel and concrete factory building, about 100 x 400 ft., at South-eastern Avenue and Belt Railway.

INDIANAPOLIS.—The plant of the Stenotype Company is being operated to capacity for the manufacture of fuse parts for the government, order for which has recently been received.

MONTEREY.—The Monterey Electric Light & Power Company, recently incorporated with a capital of \$60,000, has had plans prepared for the construction of a new one-story electric power plant, about 50 x 125 ft., to cost \$50,000.

Kentucky

CLOVERPORT.—Fire recently destroyed a section of the plant of the Standard Oil Company, including two tanks containing about 17,000 gal. of gasoline and oil.

Maryland

BALTIMORE.—The Bethlehem Steel Company has made announcement that plans are under consideration for extensions and additions at its Sparrows Point plant.

BALTIMORE.—The Maryland Bolt Works will build a new addition to its plant to provide for increased capacity.

BALTIMORE.—Plans have been filed by the Federal Tin Company, East Barre Street, for the construction of additions to its plant to provide for increased capacity. Contract for erection has been awarded.

EDGEWOOD.—The United States Government has made announcement that approximately 1000 acres of land adjoining the Aberdeen proving grounds have been acquired for the erection of a large new plant to be devoted to the production of poisonous gases.

HAGERSTOWN.—The Western Maryland Railroad Company has awarded a contract for the erection of a new wheel-shop at its local plant.

ANNAPOLIS.—The State Agricultural Line Board is planning for the acquirement of a site now under consideration to provide for the construction of a new limestone crushing plant.

Massachusetts

BOSTON.—Knox & Morse Company, 96 High Street, has recently awarded a contract to Edward B. Smith, Auburn Street, Waltham, for the erection of a new chemical shop at 41 Everett Street, Allston, to be one-story, of brick construction.

WORCESTER.—The Peter Wood Dyeing Company has recently taken over the plant and property of the Thibert Manufacturing Company, Millbury, and will use as an extension to its present plant.

Minnesota

MINNEAPOLIS.—The Gas Traction Foundry Company, 2907 Southeast Fourth Street, has recently had plans prepared for the construction of a new one-story addition, about 100 x 300 ft., to its foundry, to cost \$70,000. W. L. Alban, Endicott Building, St. Paul, is architect.

STILLWATER.—The Twin City Forge & Foundry Company has recently filed plans for the construction of a new foundry, about 125 x 400 ft., to cost \$50,000. Contract for erection has been awarded.

Missouri

ST. LOUIS.—The Kardell Tractor & Truck Company is said to be considering the construction of a new plant at Oldsmar, Fla., for the manufacture of tractors and similar products.

ST. LOUIS.—The Bridge & Beach Manufacturing Company, manufacturer of stoves, ranges, etc., has recently acquired a tract of ten acres at the northeast corner of the intersection of the Belt Line and Union Avenue, as a site for the construction of a new plant.

KANSAS CITY.—The Witte Engine Works, Sixteenth Street, manufacturer of gas engines, etc., will build a new one-story addition to its plant to provide for increased capacity. The structure is estimated to cost \$10,000. Contract for erection has been awarded.

SAGINAW.—The Griffith Lead & Zinc Company is planning for extensive development work on its 750-acre tract recently leased from the Saginaw Mining & Leasing Company. Plans are also under consideration for the construction of a new 350-ton concentration plant.

WENTWORTH.—The Wentworth Lead & Zinc Company, recently incorporated with a capital stock of \$200,000, has completed its organization plans, and will develop about 40 acres of lead and zinc properties. A new 250-ton mill will be constructed. D. C. Morris is president.

Montana

GREAT FALLS.—The Anaconda Company is considering plans for immediate construction work on a large new plant at its Boston and Montana works, to be devoted to the electrolytic production of ferromanganese, which is essential in the manufacture of steel.

Nevada

YERINGTON.—The Bluestone Mining & Smelting Company is rushing to completion the construction of a large new plant at its local properties, including two 8-ft. Hardinge ball-mills and flotation apparatus, and it is expected that operations will be inaugurated within the next few weeks.

New Jersey

JERSEY CITY.—Fire, on March 2, damaged the plant of the Crew Levick Company, Ravine Road and West Shore Railroad, to the extent of about \$10,000.

OLD BRIDGE.—Due to the acute shortage of coal, the Brookfield Glass Company has been compelled to suspend operations until permanent relief is in sight.

HARRISON.—The National Oil Products Company, Essex Street, has awarded a contract for alterations and improvements in its plant to cost about \$63,000. The Becker Construction Company, 361 Grove Street, Newark, is the contractor.

RAHWAY.—Fire, on March 4, partially destroyed the plant of the Rahway Chemical Company, Broad Street and Maple Avenue, with total loss estimated at \$15,000. Irwin S. Joseph is president.

BUTLER.—A portion of the plant of the Gulf Oil Refining Company was destroyed by fire on Feb. 21, including four tanks containing about 30,000 gal. of oil.

DELAWANNA.—The Worthen & Aldrich Company, operating a large local dye works, will build a new addition to its plant, about 80 x 160 ft., to cost about \$250,000. Plans for the structure have been prepared.

PAULSBORO.—Fire, on Feb. 21, destroyed the hexite catalytic house at the Repauno plant of the E. I. du Pont de Nemours Company at Gibbstown, with total loss estimated at about \$50,000. It is said the destroyed structure will be immediately rebuilt.

DELANCO.—The Consolidated Paper Tube Company, Philadelphia, Pa., is having plans prepared for the construction of a new two-story and basement brick local plant, about 50 x 80 ft.

New York

NEW YORK.—The American Chemical Products Company, a Delaware incorporation, has filed authorization papers to operate in New York. G. B. McLeod, 23 Liberty Street, is local representative.

GLENDAL, LONG ISLAND.—The James A. McCafferty & Sons Manufacturing Company, 506 Driggs Avenue, Brooklyn, has had plans prepared for the construction of a new one-story metal works addition to its paint manufacturing plant. The structure will be about 30 x 58 ft.

LONG ISLAND CITY.—The Van Iderstine Company is having plans prepared for the erection of a new addition to its tallow manufacturing plant at Newtown Creek. Edward Hahn, Bridge Plaza, Long Island City, is architect.

MARINERS' HARBOR, STATEN ISLAND.—The Proctor & Gamble Manufacturing Company, Cincinnati, Ohio, has had plans prepared for the construction of six new factory buildings at its plant at Port Ivory, to provide for increased capacity. The Ferro-Concrete Construction Company, Richmond and Harriet Streets, Cincinnati, has the contract for erection.

CORTLAND.—The Cortland Specialty Company, manufacturer of chemicals, etc., is having preliminary plans prepared for the reconstruction of the section of its one and two-story plant, about 87 x 177 ft., recently destroyed by fire. C. W. Clark, 9 Charles Street, Cortland, is architect.

TROY.—Operations have been discontinued at the Breaker Island plant of the American Steel & Wire Company, near Troy, and it is said that the property will be sold. The site consists of about 100 acres, adjacent to the tracks of the New York Central Railroad.

FULTON.—The Oswego Falls Pulp & Paper Company, 314 South First Street, has had plans prepared for the erection of a new two-story addition, to provide for increased capacity. The structure is estimated to cost about \$20,000.

Ohio

CINCINNATI.—The Newport Rolling Mill Company has acquired property near Lowell Street, and will use it as a site for the construction of a new addition to its plant. J. B. Andrews is president.

CINCINNATI.—The Cincinnati Pulley Machinery Company has taken out a building permit for the erection of a new addition to its plant on East Third Street, to cost about \$6,000.

CLEVELAND.—Fire recently partially destroyed the foundry of the Federal Metal Company, 6621 Morgan Avenue, with loss estimated at \$20,000.

CLEVELAND.—The Variety Iron & Steel Works has acquired property, about 130 x 156 ft. on Hamilton Avenue, Northeast, near East Thirty-third Street, and is said

to be considering the erection of new additions to its plant.

CLEVELAND.—A building permit has been taken out by the American Steel & Wire Company for the construction of a new benzol plant, about 95 x 110 ft., and a new storage plant, 42 x 146 ft., at Campbell Road, Southeast, and the Ohio Canal, to cost \$57,000 and \$15,000, respectively.

FINDLAY.—The Buckeye Traction Company is having plans prepared for the construction of a new factory building, and will immediately install a new electric converting furnace to be used for steel production. The plant is estimated to cost \$50,000.

HAMILTON.—Contract has been awarded by the Hamilton Furnace Company for extensive improvements and additions to its plant in Cokeotto, near Hamilton, including the construction of an ore bridge and car dumper, the entire work to cost about \$500,000. Hunkin & Conkey, Cleveland, are the contractors.

LIMA.—The Monarch Machine Company has awarded a contract to the Concrete Steel Construction Company, Lima, for the erection of a new one-story steel and concrete addition to its plant, about 80 x 200 ft.

TOLEDO.—The F. L. Royster Guano Company has acquired seven acres of land on the north side of the Michigan Central Railroad, near the Toledo Disposal plant, and has awarded contracts for the construction of a large new fertilizer works, the main building of which will be 150 x 500 ft., of brick and cement construction. The plant will have a capacity of about 150,000 tons of fertilizer per year, and about 200 hands will be employed for initial operations.

YOUNGSTOWN.—The Liberty Steel Company is making rapid progress in the construction of its new plant near Warren, to be used for the production of tin. The plant comprises three large mill buildings with tin stacks, administration building and auxiliary structures. It is expected that the new plant will be completed and ready for operation by April 1.

Oklahoma

PICHER.—The Bendene Mining Company is considering plans for the construction of a new concentration plant at its lead and zinc properties.

MIAMI.—J. E. Hellams, 217 South Seventh Street, Muskogee, and associates, are planning for the organization of a new company to be capitalized at \$100,000 for the purpose of developing lead and zinc properties in the Miami field. A concentration plant is also planned.

QUAPAW.—The Quapaw Mining Company has plans under consideration for the construction of a new mill on its 80-acre lease, near the Lincolnville station, south of Quapaw.

QUAPAW.—The Medical Mining Company is planning for the immediate construction of a new 250-ton mill at its properties west of Quapaw.

Oregon

GRANT'S PASS.—W. A. Sharp, Grant's Pass, and L. C. Sharp, Plattsouth, Neb., have acquired the placer mining property of the Hydraulic Mining Company, Upper Jump-off-Joe Creek, Jackson County. Extensive improvements will be made on the property, including the installation of hydroelectric precipitating value-recovering machinery.

Pennsylvania

BERWYN.—The American Bronze Company has had plans prepared for the construction of a large new foundry building at its plant.

MARCUS HOOK.—The Sun Oil Company has taken bids for the erection of a new two-story brick administration building, about 35 x 47 ft., at its plant.

PHILADELPHIA.—The Tacony Steel Company has recently acquired property at Bleigh and Spring Streets, and Bleigh and Eugene Streets, for a consideration said to be \$65,000, and is considering the construction of additions to its plant on the sites.

PHILADELPHIA.—The Pecora Paint Company, Fourth and Sedgley Streets, has acquired the two and three-story factory buildings, at Sedgley and North Penn Railroad, for a consideration of \$100,000, to be used as a new manufacturing plant.

PHILADELPHIA.—The E. I. du Pont de Nemours Company has formally taken over the plant of Harrison's, Inc., manufacturer of paints and chemicals, at Thirty-fourth Street and Gray's Ferry Road, by the recording of the necessary deed.

PITTSBURGH.—Officials of the Pittsburgh Testing Laboratory, one of the best known institutions of its kind in the coun-

try, have turned over to the United States Government, for the duration of the war, the entire five-story plant, with full equipment of chemical, physical and analytical laboratories, scientific instruments, laboratories for testing cement and apparatus for inspecting and testing steel. George H. Clapp is president.

Rhode Island

PROVIDENCE.—The Nicholson File Company, Acorn Street, has commenced the construction of three new additions to its plant on Kinsley Avenue.

Tennessee

CENTERVILLE.—The Tennessee-Illinois Phosphate Company, recently incorporated with a capital of \$200,000, has acquired about 300 acres of land and is planning for the construction of a plant for mining, milling and refining phosphate.

KNOXVILLE.—The Tennessee Manganese Company has filed notice of an increase in its capital from \$20,000 to \$200,000, to provide for extensive improvements in its mining facilities, and the construction of a new electric steel furnace to cost about \$100,000. The new furnace will have a capacity of 25 tons of manganese daily for initial operations.

MEMPHIS.—Fire, on February 26, damaged the plant of the Webster-Warnock Chemical Company, Union Street, to the extent of \$25,000.

Texas

GREENVILLE.—The North Texas Oil & Refining Company is planning for the immediate construction of a large refinery on a site at the junction of the Mineola branch of the M. K. Railway with the Texas Midland Railway, to cost about \$250,000. The plant will have a daily capacity of 5000 barrels.

Utah

EUREKA.—Plans are under way for the organization of a company to be known as the Majestic Copper Mining Company, with capitalization of \$1,000,000, for the development of a large tract of land in the Erickson district, west of Eureka. Harry Webber, Jr., New York, is interested in the company.

Virginia

NORFOLK.—The Norfolk Glass Manufacturing Company, recently incorporated with a capital of \$250,000, has acquired ten acres of land near the junction of the Norfolk Southern and the Virginia Railways, and is planning for the immediate construction of a large plant for the manufacture of glass and glassware. About 300 hands will be employed.

Wisconsin

PLATTEVILLE.—Fire at the plant of the White Rose mine, one of the Gus E. Brown properties, entailed a loss of about \$15,000. The destroyed section will be immediately rebuilt.

PLATTEVILLE.—The Wisconsin Zinc Company has completed the construction of a new 500-ton mining and milling plant at its Copeland mine in the Shullsburg district.

MILWAUKEE.—The Milwaukee Paper Box Company, 400 Florida Street, has had plans prepared for the erection of a new five-story and basement factory, about 100 x 150 feet, at South Pierce Street and Muskegon Avenue. The estimated cost of the structure is \$150,000.

HALIFAX.—The plant of the Martin Sembur Paint Company was recently partially destroyed by fire, with total loss estimated at \$70,000.

New Publications

TESTS OF OXY-ACETYLENE WELDED JOINTS IN STEEL PLATES. By Herbert F. Moore. Bulletin No. 98 of University of Illinois, Experiment Station, published by the University, Urbana, Ill.

MANGANESE AND CHROMIUM. By E. S. Boalich. Preliminary report of the California State Mining Bureau, Ferry Building, San Francisco.

COST-ACCOUNTING FOR OIL PRODUCERS. By Clarence G. Smith. Bulletin No. 158, Bureau of Mines. Obtainable from the bureau at Washington, D. C.

BIENNIAL REPORT OF THE STATE GEOLOGIST 1915-1916. Issued by the North Carolina Geological and Economic Survey.